Technical skills, the key to succes? A study on talent development and selection of youth soccer players

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Barbara C. H. Huijgen

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Chapter 1

Introduction

Aim thesis:
To gain insight into the talent development and selection process of youth soccer players by examining the development of technical skills in relation to soccer performance

Soccer

Soccer is the world's most popular sport (Dunning, 2010; Guttman, 2010). This is also the case in the Netherlands in which over 1.2 million players are active in a club, this is 7% of the entire population (CBS, 2011; KNVB, 2011a). We marvel at seeing a world class player performing incredible actions with the ball. Since soccer has become big business, considerable resources are allocated to enable players to reach professional soccer (Abbott & Collins, 2004; Abbott, Button, Pepping, & Collins, 2005; Reilly, Bangsbo, & Franks, 2000). Each youth soccer player probably dreams of playing professional soccer and representing the National team. However, only about 900 of the more than 500,000 youth soccer players ultimately obtain a professional career, and just a small amount of these players are invited to play for the National team.

In the Netherlands, soccer scouts observe youth players during local competitions and give players who attract their attention the opportunity to join a premier league club for several practice sessions. The clubs give the players who they believe are the most talented players a chance to enroll in their developmental program, these are usually the best players at that moment. Currently, 13 regional soccer development programs exist in the Netherlands. The aim of these programs is to educate talented players under optimal circumstances to become a professional player (KNVB, 2011b).

Talent development and selection in soccer

Talent development implies that players are provided with a suitable learning environment so that they have the opportunity to realise their potential (Williams & Reilly, 2000). A schematic overview of the development of a talented player is illustrated in Figure 1.1, which includes the importance of the environment (developmental program) to fulfil the development. Developmental programs facilitate the development of the player that is essential to eventual professional performance. Talent development is an ongoing process in the road to professional soccer, this is indicated in the arrow in Figure 1.1. When players get older, they need to constantly increase their performance in their multidimensional performance characteristics in order to be able to move up towards a professional career in soccer.

At present, professional soccer clubs rely on the assessment of scouts and/or coaches to identify talented players for their developmental program, this 'coach-driven' method of talent identification is mainly based on intuitive knowledge (Meylan, Cronin, Oliver, & Hughes, 2010). Reliable identification of future professional players permits clubs to focus their expenditure on developing a smaller number of players, representing a more effective management of their resources. Objective data collected by sports scientists can help confirm initial intuitions of scouts and coaches with regard to players' strengths and weaknesses (Williams & Reilly, 2000). Furthermore, research can assist in identifying talents who would not have been selected by scouts. In actual fact, a talented player should not only perform better than their peers during training and competition, in addition this player should also have the potential to become a professional player (Helsen et al., 2000; Howe et al., 1998).

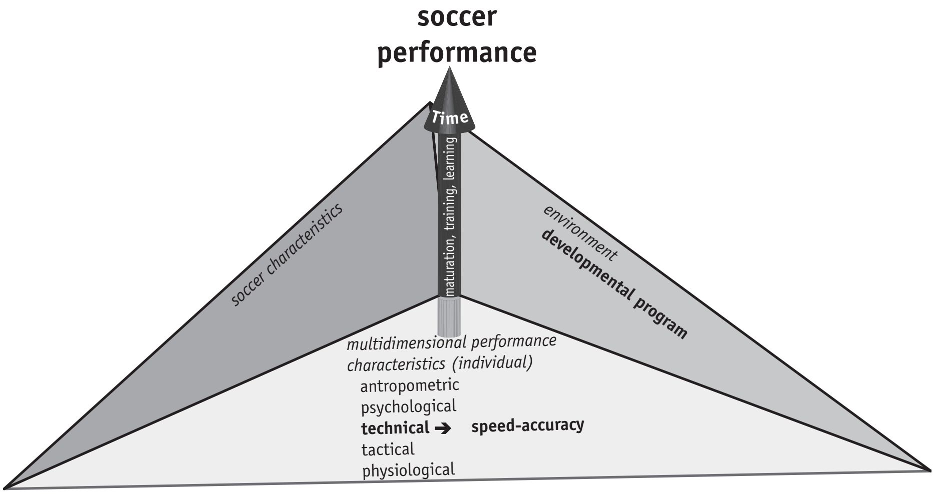

Figure 1.1 Schematic overview for the development of a talented soccer player (adapted version Elferink-Gemser, & Visscher, 2011)

The theoretical framework to guide talent development programs should take into account both the dynamic and multidimensional nature of talent (Phillips, Davids, Renshaw, & Portus, 2010; Vaeyens, Lenoir, Williams, & Philippaerts, 2008). The intrinsic dynamics of every player is unique and developed by many constraints including maturation, training, learning, and environment, which all interact to form performance and eventually reaching professional soccer (Davids, Button, & Bennet, 2010). The multidimensional nature in soccer is acquired by the following performance characteristics: anthropometric, physiological, technical, tactical and psychological characteristics (Burgess & Naughton, 2010; Figueiredo, Goncalves, Coelho E Silva, & Malina 2009; Helsen & Starkes, 1999; Reilly, Williams, Nevill, & Franks 2000b; Vaeyens et al., 2006; Ward & Williams, 2003). During youth and adolescence players develop themselves virtually in every aspect of these multidimensional performance domain, emphasizing the individual dynamics of the players (Phillips et al., 2010, Elferink-Gemser, Jordet, Coelho E Silva, & Visscher, 2011). Figure 1.1 includes the dynamic and multidimensional nature of a soccer player on its way to the top.

Measuring the potential of the players, to indicate which player has more chance to ultimately become a professional player, is challenging, since players mature, train, and learn over time (Figure 1.1), which together result sin diverse development patterns. Differences in maturity can be extensive, players who are born early in the selection year and players who are early matures often have the advantage of being bigger, stronger, faster (Hirose 2009; Musch & Grondin, 2001). As a result, they may be more successful than their younger counterparts. Younger and less mature players may be regarded as less talented during the selection process (Helsen, Starkes, & Van Winckel, 1998), however they may have more potential to ultimately make it to the top. This phenomenon creates a bias in the birth date distribution of selected players and is referred to as the relative age effect (RAE) (Barnsley, Thompson, & Barnsley, 1985). Training and experience are also known as important characteristics of superior performance (e.g., Ericsson, Krampe, & Teschromer, 1993). However, it is not just the time spent practicing that is important; training must be directed at improving or developing a skill (deliberate practice) (Ericsson et al., 1993). In this light, it is of great importance that players with potential to become a professional player receive specialized training to develop themselves to the greatest extent. Learning in soccer involves acquiring new, or modifying existing skills. Performing the essential soccer skills is a requisite in being able to participate in the soccer game. However, a lack of information exists in the developmental curve of these essential skills in talented players. A more in-depth understanding of the development of skills in talented players who ultimately reach professional soccer can provide insight into the talent development process.

Only few of the initial identified talented players ultimately reach professional soccer. As the youth players progress through the development program, some players are allowed to continue training (selected) while others are forced to leave (de-selected). Talent selection is the ongoing process of identifying players at various stages who demonstrate prerequisite levels of performance for inclusion in a selection team (Williams & Reilly, 2000). At the end of each season the trainers, coaches and technical staff of the development programs decide either a player is selected or de-selected for the following year. With respect to the latter, such players may be asked to leave due to insufficient performance (compared to their peers) or because they are anticipated to be unable to reach professional soccer. The players who are de-selected, were earlier marked as talent, however due to the dynamic nature of talent it is very complex to predict their developmental patterns (Phillips, Davids, Renshaw, & Portus, 2010; Vaeyens, Lenoir, Williams, & Philippaerts, 2008). The older a player gets, the development of the player becomes more apparent, this indicates if this development pattern is satisfactory to reach high performance in soccer, or not. The opportunity a player has of reaching the professional level is greatly reduced if he is de-selected, indicating the importance of such a decision. However, despite the importance of these types of decisions, little is known about the criteria upon which they are based. Therefore, scientific research can assist in providing the talent development programs with objective data of the players performance and underscore the key elements of the talent development and selection process (Williams & Reilly, 2000).

Longitudinal research following the development of a group of talented players over time is necessary to examine the non-linear performance characteristics that appear over time (Abbott et al., 2005; Elferink-Gemser, Visscher, Lemmink, & Mulder, 2007; Phillips et al., 2010; Vaeyens et al., 2008). Where cross-sectional research on talented soccer players will only partially assist in identifying these characteristics (Morris, 2000), longitudinal research in which a large group of initially identified talented soccer players are monitored during adolescence and followed until adulthood does make it possible to understand the discriminating characteristics between players who ultimately reach professional soccer and those who do not. (Reilly et al., 2000a; Williams & Reilly, 2000; Reilly et al., 2000b).

Technical skills in soccer

Soccer is a highly intermittent, dynamic sport involving skilled movements (Bloomfield, Polman, O'Donoghue, & McNaughton, 2007; Cometti et al., 2001; Mohr, Krustrup, & Bangsbo, 2003). The essence of the game is to score more goals than the opponent. To accomplish this goal, players need to execute various skilled movements, both with and without the ball. An original definition of skill is: 'the learned ability to bring about pre-determined results with maximum certainty, often with the minimum outlay of time or energy or both' (Knapp, 1963). A more recent definition of skill is: 'the consistent production of goal-oriented movements, which are learned and specific to the task' (McMorris, 2004). In order for players to acquire and execute soccer skills adequately, it is important that they are equipped with the fundamental motor skills, such as sprinting, agility, acceleration, etc. (e.g., Strand & Wilson, 1993; Burton & Miller, 1998; Seefeldt, 1980). Fundamental motor skills are seen as essential precursors or related factors to technical skills and therefore excellence in soccer (Moore, Collins, & Burwitz, 1998).

Technical skills are classified as on-the-ball-performance actions and consist of: ball control, passes, crosses, dribbles, tackles, headers, shots, corners, free-kicks and throw-ins (Rampinini et al., 2007; Taylor, Mellalieu, James, & Shearer, 2008). Technical skills are a prerequisite for playing soccer and are crucial in soccer performance. These crucial moments consist of winning possession of the ball, deceiving an opponent by passing or dribbling, and most importantly to score a goal (Bangsbo, 1994; Reilly et al., 2000b; Rienzi et al., 2000). Merely by possessing technical skills it is impossible to win a game and ultimately to become a professional player.

The speed of dribbling is considered critical to the outcome of the game, with elite soccer players performing 150-250 brief intense actions during a game (Mohr, Krustrup, & Bangsbo, 2003). Therefore, the ability to sprint and dribble at high speed is essential for performance in soccer (Bloomfield, 2007; Cometti et al., 2001; Little & Williams, 2005; Reilly et al., 2000a; Spinks, Murphy, Spinks, & Lockie, 2007; Sheppard & Young, 2006). Expertise in soccer depends not only on the speed of executing the technical skills but also the precision (accuracy) of the skill performances influences the result (Russell & Kingsley, 2011). Therefore, the quality of the skills is dependent on the interaction between speed and accuracy of execution (Andersen & Dorge, 2011; Fitts & Possner, 1967). Information that concerns these components speed and accuracy of technical skills can provide outcome measures that are relevant for the field of talent development and selection (Russell & Kingsley, 2011). Given the importance of technical skills, this is the central theme of the current thesis (see Figure 1.1).

Normative data on the level of essential technical skills and its development in talented players is scarce. The current thesis gains more insight in technical skill development in relation to soccer skill performance. In soccer, the results of the technical skills are of the utmost important, not the esthetical aspect of executing the skill. These technical skills are effective if executed under high-velocity and high accuracy. Therefore, the technical skills in the current thesis are measured as the outcome of speed and accuracy. In the current thesis, speed of technical skills is measured as the time to dribble a certain track, the velocity of moving from one place to another. Furthermore, speed is measured as executing soccer skills under high operation speed, the velocity of performing multiple skills by barely moving.

Thesis objective and outline

The aim of this thesis is to gain more insight into the talent development and selection process of youth soccer players by examining the development of important technical skills and related factors influencing soccer performance. Youth players (age 10-21 years) performing at the highest performance level in their age category of their country are included in the current study. In chapter 2, the development of sprinting and dribbling in youth players (age 12-19 years) attending a talent development program are assessed by means of two field tests. The two tests are performed to find out about different aspects and related factors of the technical skill dribbling (acceleration versus agility). In addition, the correlation between sprinting and dribbling on each separate test is investigated to establish the possible link between sprinting and dribbling. In chapter 3 the relation between sprinting and dribbling improvement during a twelve week intensive training period is investigated in national youth soccer players (average age 20 years). In addition, it is investigated if differences exist in performance changes over the twelve week period between players with a different performance level at baseline. Chapter 4 presents longitudinal data on the relationship between the development of the technical skill dribbling during ages 14-18 and adulthood playing level. The purpose was to gain insight in the required level of the technical skill dribbling during adolescence to be capable of becoming a professional soccer player. Chapter 5 examines the selection criteria upon which trainers, coaches and staff based their decisions for soccer players, aged 16-19, to be either selected or de-selected for the following year's talent development program. Technical skills are studied in combination with the other multidimensional performance characteristics to investigate which of the characteristics seem most important to be selected for a development program. Chapter 6 features a longitudinal study on the development of essential soccer skills (including the technical skills ball control, dribbling and passing) in a group of soccer players, attending development programs, aged 10-18 years. Additionally, the differences in soccer skill performance between selected and de-selected players are highlighted. Finally, in chapter 7 the results of the different studies are combined in the general discussion. Practical implications are considered and recommendations for improvements of talent development and selection are provided.

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Chapter 2

Development of dribbling in talented youth soccer players aged 12-19 years: a longitudinal study

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Marije T. Elferink-Gemser
Wendy J. Post
Chris Visscher

Journal of Sports Sciences, 2010, 28, 689-698

Abstract

The aims of the current study were to assess the development and determine the underlying mechanisms of sprinting and dribbling needed to compete at the highest level in youth soccer. Talented soccer players aged 12-19 (n = 267) were measured on a yearly basis in a longitudinal study over 7 years, resulting in 519 measurements. Two field tests, the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test, were assessed. Anthropometric characteristics, years of soccer experience, and duration of practice were recorded. The longitudinal data were analysed with multi-level modelling. Comparing the two tests at baseline, low correlations were observed (sprinting: $r = 0.49$; dribbling: $r = 0.22$), indicating that each test measures distinct qualities (acceleration vs. agility). Low-to-moderate correlations were found between dribbling and sprinting within each test (Shuttle Sprint and Dribble Test: $r = 0.54$; Slalom Sprint and Dribble Test: $r = 0.38$). Both dribbling and sprinting improved with age, especially from ages 12 to 14, but the tempo of development was different. From ages 14 to 16 sprinting improved rapidly in contrast to dribbling; this was especially evident on the Slalom Sprint and Dribble Test. In contrast, after age 16 dribbling improved considerably but sprinting hardly improved. Besides age, the factors that contribute to dribbling performance are lean body mass, hours of practice, and playing position.

Keywords: technical skill, expert athletes, speed, performance level, playing position

Introduction

Comprehensive physiological, psychological, and tactical qualities are needed to become a professional soccer player (Bangsbo, 1994; Reilly, Williams, Nevill, & Franks, 2000b; Williams & Reilly, 2000). Another prerequisite for young soccer players to progress is that they possess a certain level of technical skills. Currently, there is no generally accepted standard test to measure technical qualities (Jaric, Ugarkovic, & Kukolj, 2001; Kukolj, Ugarkovic, & Jaric, 2003; Reilly et al., 2000b), thus it is unclear what level of technical skills is required to be among the best adolescent players. The principal technical skills are shooting, passing, ball control, dribbling (Reilly & Holmes, 1983). Dribbling speed is considered critical to the outcome of the game, with elite soccer players performing 150-250 brief intense actions during a game (Mohr, Krustrup, & Bangsbo, 2003). Therefore, the ability to sprint and dribble at high speed is essential for performance in soccer. Previous research has indicated that the better players distinguish themselves by their running speed while dribbling the ball (Malina et al., 2005; Reilly et al., 2000b; Vaeyens et al., 2006).

Dribbling in soccer can be categorized into dribble actions while accelerating and dribble actions with quick changes of direction. Acceleration is of great importance, as soccer players only cover short distances (mean distance 10-20 m) at maximal effort (Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001; Reilly, Bangsbo, & Franks, 2000a; Spinks, Murphy, Spinks, & Lockie, 2007). Furthermore, many actions in soccer involve repeated short sprinting or dribbling with changes of direction (Bloomfield, 2007; Little & Williams, 2005; Sheppard & Young, 2006). This ability to change direction rapidly is called 'agility'. Acceleration and agility while sprinting have been identified as independent qualities (Little & Williams, 2005; Young, McDowell, & Scarlett, 2001). It is not yet clear whether dribbling while accelerating and dribbling while performing an agility task measure different components of the technical skill of dribbling, and what the exact relationship is between sprinting and dribbling over the same course. In the current study, therefore, we examined sprinting and dribbling in two soccer-specific field tests: the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test (Lemmink, Elferink-Gemser, & Visscher, 2004). The Shuttle Sprint and Dribble Test measures acceleration; sprinting and dribbling over short distances with quick changes of direction. The Slalom Sprint and Dribble Test measures slalom sprint and dribble performance, relevant for deceiving opponents. The Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test comprise several change-of-direction tasks (180° vs. 53.2°), both over 30 m.

Normative data for talented young soccer players can provide insight into the sport-specific skills necessary to be among the best national players in each age group. Although several researchers recommend applying a longitudinal design for profiling the development of sport-specific skills in talented players (Nieuwenhuis, Spamer, & van Rossum, 2002; Reilly et al., 2000b; Williams & Reilly, 2000), such research is scarce. A longitudinal design can determine the key changes in the sport-specific skill of dribbling that occur as a result of development and practice (Williams & Reilly, 2000).

Previous research has assessed the role of each playing position (Di Salvo et al., 2007; Mohr et al., 2003; Rienzi, Drust, Reilly, Carter, & Martin, 2000). One study (Mohr et al.,

2003) reported that attackers and full-backs sprinted more than midfielders and defenders in professional soccer. Research on elite young Brazilian soccer players found that the fewest sprints were made by full-backs and the most sprints by attackers; also, attackers and offensive midfielders sprinted more with the ball than players from other positions (Pereira, Kirkendall, & Barros, 2007). Other research on young non-elite soccer players found that forwards were the fastest players in the 30-m straight and agility sprint, followed by midfielders (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007a). These results indicate that attackers are the best sprinters, although limited information is available regarding which position shows the best dribbling performance.

Longitudinal modelling can indicate which factors contribute to the development of dribbling performance in soccer. Previous cross-sectional research on talented youth soccer players has reported improvements on dribbling and sprinting tests with age (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007b; Kukolj et al., 2003; Rosch et al., 2000; Vanderford, Meyers, Skelly, Stewart, & Hamilton, 2004). It has also been shown that practice is a major feature for the development of soccer skills (Ericsson, Krampe, & Teschromer, 1993; Helsen, Hodges, Van Winckel, & Starkes, 2000; Helsen, Starkes, & Hodges, 1998). Previous research also showed height to be a significant factor for running speed in a group of talented soccer players (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004). Another contributor to performance in sports is lean body mass, which is related to body muscle percentage and body fat percentage. Various test batteries have revealed that athletes who perform better on change-of-direction sprint tests, also over short distances, tend to have a lower percentage body fat (Gabbett, 2002; Meir, Newton, Curtis, Fardell, & Butler, 2001; Negrete & Brophy, 2000; Reilly et al., 2000a). As the hypothesis is that sprinting and dribbling (speed) are correlated to some extent, the variables that influence sprinting might also influence dribbling in talented youth soccer players.

The overall purpose of the current study was to gain more insight into the development and underlying mechanisms of an essential technical skill (i.e. dribbling) that is needed to compete at the highest level in youth soccer, and subsequently to be part of a select group following a developmental soccer programme. The first step towards accomplishing this goal was to establish the possible link between sprinting and dribbling as well as the possible connection between the two tests. Our hypothesis is that sprinting and dribbling on the same course are partly related, although the skill of dribbling is more complex than that of sprinting, therefore, the fastest sprinters are not expected always to be the fastest on the dribble. The second aim of this study was to investigate the development of sprinting and dribbling among talented youth soccer players aged 12-19 years. We believe that both sprinting and dribbling improve over the years and hypothesize that the greatest improvements will occur at younger ages. The third aim was to determine whether dribbling performance can be predicted by age, height, lean body mass, cumulative years of soccer experience, soccer practice, additional practice per week, and playing position. Earlier studies indicated that all these factors help to predict sprinting performance; we hypothesized that sprinting and dribbling are related, thus it is expected that the above factors can also predict dribbling performance.

Methods

Participants
Talented youth soccer players from two talent development programmes of premier league soccer clubs (i.e. soccer schools in the Netherlands) participated in this longitudinal study. From 2001 to 2008 measurements were taken annually, with the exception of 2004, resulting in seven measurement occasions. Only data for players who started at the soccer schools between 2001 and 2006 were used in the study. This resulted in 519 measurements with a total of 267 players. The players competed at the highest level, and represented the best 0.5% of soccer players in their age group (National Soccer Association, KNVB). Each year all measurements were taken during the competitive season; this resulted in well-trained players who followed a programme of intensive practice at their soccer school. Table 2.1 shows the number of players and number of measurements per age category.

Since goalkeepers' technical skills differ significantly from those of outfield players, data from goalkeepers was excluded from the current analysis. The outfield players were classified as defenders (central and external/full-backs and wing defenders), midfielders (central and external), and attackers (forwards). As there were overlaps in ages, it was possible to estimate a consecutive 8-year development pattern for ages 12-19 years. The age of the participants was recorded in months at the time of measurement to create standardized age groups. A 14-year-old player was defined as a player tested within the age range 13.50-14.49 years.

Table 2.1 Number of players and number of measurements per age category

Age Category	Average age ± SD	Number of measurements					
		1	2	3	4	5	Total
12	12.03 ± 0.31	6	10	8	0	0	24
13	12.98 ± 0.26	2	23	17	4	1	47
14	13.98 ± 0.27	17	40	23	8	1	89
15	14.96 ± 0.27	22	37	32	8	0	99
16	16.01 ± 0.27	12	32	33	6	1	84
17	17.01 ± 0.27	12	38	28	5	1	84
18	17.96 ± 0.30	16	25	17	5	0	63
19	18.80 ± 0.30	6	11	7	4	1	29
Total measurements		**93**	**216**	**165**	**40**	**5**	**519**
Number of players		**93**	**108**	**55**	**10**	**1**	**267**

Procedures

All players were informed of the procedures of the study before providing their verbal consent to participate. The clubs and trainers gave permission for this study to go ahead, and the procedures were in accordance with the ethical standards of the Medical Faculty of the University of Groningen. The players completed the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test on an artificial grass soccer field at the same location on each measurement occasion. The measurements took place at the end of the competitive season, which varied from March to May. Ambient temperature, humidity, and wind conditions were documented; we did our best to match conditions across measurement occasions. Height, weight, and percentage body fat were measured. The latter was estimated by means of leg-to-leg bioelectrical impedance (BIA) analysis (Valhalla BIA, Valhalla, Inc., San Diego, CA) (Nunez et al., 1997). Lean body mass was calculated by subtracting the percentage of body fat from the total weight of the players. Date of birth, playing position, cumulative years of soccer experience, hours of soccer and additional practice were also recorded.

Shuttle Sprint and Dribble Test

The protocol for this test consisted of three maximal sprints of 30 m and three maximal sprints of 30 m while dribbling a soccer ball (Lemmink et al., 2004). Each 30-m sprint has three 180° turns (Figure 2.1). Sprints were measured by means of photocell gates (Eraton BV, Weert, Netherlands) placed 1.05 m above the ground (approximately at hip height). Shuttle sprint and dribble times were indicated by the time covered in the fastest of three sprints.

Slalom Sprint and Dribble Test

The protocol for this test consisted of a maximal slalom sprint and a maximal slalom sprint while dribbling a soccer ball (Lemmink et al., 2004). Twelve cones were placed in a zigzag pattern, and the participant had to slalom the 30 m course as fast as possible (Figure 2.2). Sprints were timed using a stopwatch.

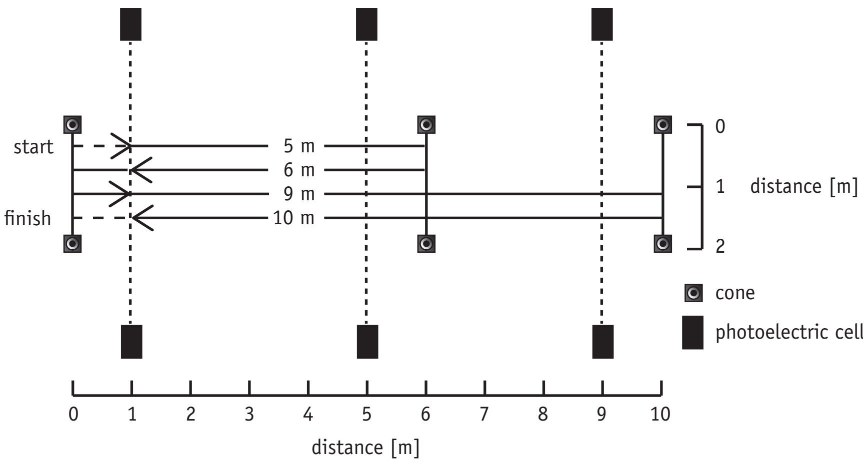

Figure 2.1 Course for the Shuttle Sprint and Dribble Test

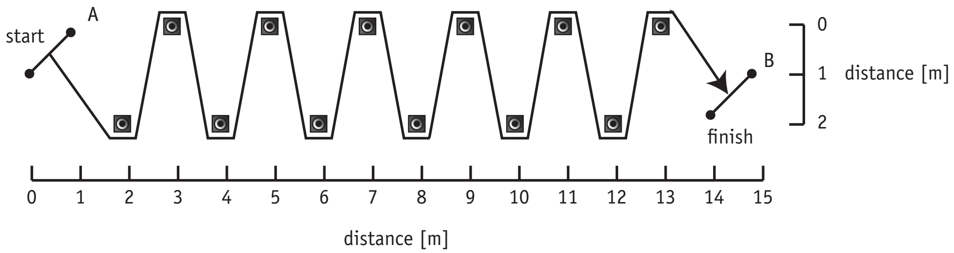

Figure 2.2 Course for the Slalom Sprint and Dribble Test

Since both the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test were primarily developed for field hockey players (Lemmink et al., 2004), the psychometrics of these tests was assessed for soccer players. The reliability of the Shuttle Sprint and Dribble Test was assessed during pilot testing of 19 youth soccer players aged 12-19 years (M = 15.4; SD = 1.9), and the reliability of the Slalom Sprint and Dribble Test was tested in 18 players aged 12-19 years (M = 15.6; SD = 1.8). Players were tested twice with 2 days between the first and second measurement. The results showed good relative as well as absolute test–retest reliability. The intra-class correlation (ICC) for the Shuttle sprint was 0.81 and absolute reliability 0.20 (95% CI: –0.12 to 0.52). For the Shuttle dribble, reliability (ICC) was 0.74 and absolute reliability –0.02 (95% CI: –0.37 to 0.34). For the Slalom sprint, the ICC was 0.79 and absolute reliability was 0.20 (95% CI: 70.02 to 0.42). Finally, for the Slalom dribble, the ICC was 0.71 and absolute reliability –0.26 (95% CI: –1.85 to 1.33).

Statistical analysis

Mean scores and standard deviations were calculated for the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test for each age group and playing position as well as for possible factors influencing technical performance on the tests (height, lean body mass, cumulative years of soccer experience, soccer practice per week, and additional practice per week). On the players' first measurement, links between performances on the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test, and between sprinting and dribbling within one test, were established using Pearson's correlation coefficient (*r*).

Longitudinal changes in Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test performance were investigated with multi-level models using the linear mixed-model procedure in SPSS version 14.0 (SPSS, Inc., 2005). Multi-level models can handle data that are not independent, as is the case in a longitudinal design. The advantage of multi-level models is that the number of measurements and the temporal spacing of measurements may vary between players, assuming that the missing data are random (Landau & Everitt, 2004; Peugh & Enders, 2005; SPSS, Inc., 2005). The first step in the multi-level analysis was to create prediction models of the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test that included age as an independent factor.

By means of the multi-level analyses, we were able to determine whether the performance changes across age groups significantly differ from each other. The second step created a multi-level model in which Level 1 was the repeated measures within individual players and Level 2 the differences between individual players. Possible predictors for the multi-level model are age, age2, height (m), lean body mass (kg), cumulative years of soccer experience, soccer practice per week (hours), additional practice per week (hours), and playing position. Both age and age2 were entered in the model to find the best model fit. The hypothesis was that dribbling performance increases most rapidly at a younger age. At older ages, the improvement per year is expected to be less marked, thus age2 was also entered in the model, to indicate if the best model fit is linear or a quadratic curve.

The changes over time in the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test were modelled. Random intercepts and random slopes were considered, allowing a unique intercept for each individual player and properly accounting for correlations among repeated measures within individual players (Peugh & Enders, 2005). The model fit was evaluated by comparing Akaike's information criterion (deviance) of the empty model, the model without predicting variables, with the final model. An alpha of 0.05 was adopted for all tests of significance.

Results

Table 2.2 shows the players' performances on the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test by position and age group. Soccer players improved sprinting and dribbling performance with age.

Table 2.2 Mean scores (+ SD) of talented soccer players on the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test, presented by age and position

Age		n	Shuttle sprint (s)	Shuttle dribble (s)	Slalom sprint (s)	Slalom dribble (s)
12	Defenders	5	8.56 + 0.52	10.57 + 0.48	15.10 + 0.31	22.56 + 1.42
	Midfielders	10	8.83 + 0.34	10.33 + 0.50	15.25 + 1.14	23.64 + 3.23
	Attackers	9	8.59 + 0.27	10.38 + 0.80	15.15 + 0.58	22.49 + 1.20
	Total	24	8.69 + 0.37	10.40 + 0.60	15.18 + 0.80	22.98 + 2.29
13	Defenders	17	8.53 + 0.39	10.15 + 0.41	14.73 + 0.65	22.56 + 1.92
	Midfielders	18	8.49 + 0.29	10.00 + 0.56	14.64 + 0.65	21.22 + 1.38
	Attackers	12	8.39 + 0.31	9.88 + 0.54	14.66 + 0.82	22.18 + 2.60
	Total	47	8.48 + 0.33	10.03 + 0.51	14.67 + 0.68	21.84 + 1.96
14	Defenders	32	8.39 + 0.32	10.13 + 0.52	14.41 + 0.74	21.74 + 1.46
	Midfielders	32	8.41 + 0.38	9.83 + 0.52	14.12 + 0.64	21.19 +1.70
	Attackers	25	8.47 + 0.36	10.13 + 0.83	14.47 + 0.91	21.67 + 1.71
	Total	89	8.42 + 0.35	10.02 + 0.64	14.32 + 0.77	21.52 + 1.62
15	Defenders	34	8.20 + 0.28	9.91 + 0.46	14.18 + 0.78	21.44 + 1.74
	Midfielders	32	8.34 + 0.33	9.83 + 0.45	14.03 + 0.74	20.91 + 1.46
	Attackers	33	8.27 + 0.36	9.80 + 0.52	14.20 + 0.73	21.84 + 2.10
	Total	99	8.27 + 0.32	9.85 + 0.48	14.14 + 0.75	21.40 + 1.81
16	Defenders	32	8.09 + 0.40	9.75 + 0.54	14.14 + 0.92	22.26 + 2.19
	Midfielders	26	8.06 + 0.42	9.62 + 0.48	13.66 + 0.82	20.46 + 1.55
	Attackers	26	8.10 + 0.30	9.53 + 0.58	13.96 + 0.83	21.42 + 1.69
	Total	84	8.08 + 0.37	9.64 + 0.54	13.94 + 0.87	21.44 + 1.98
17	Defenders	31	7.97 + 0.29	9.44 + 0.35	13.78 + 0.70	21.43 + 1.79
	Midfielders	31	8.12 + 0.31	9.52 + 0.49	13.91 + 0.69	20.28 + 1.53
	Attackers	22	7.97 + 0.29	9.53 + 0.45	13.91 + 0.96	20.70 + 1.66
	Total	84	8.03 + 0.30	9.49 + 0.43	13.86 + 0.76	20.81 + 1.72
18	Defenders	23	8.00 + 0.29	9.40 + 0.56	13.79 + 0.69	21.35 + 1.85
	Midfielders	24	8.02 + 0.21	9.46 + 0.43	13.70 + 0.82	20.11 + 1.50
	Attackers	16	8.00 + 0.27	9.49 + 0.42	13.92 + 0.68	20.87 + 1.53
	Total	63	8.01 + 0.26	9.45 + 0.47	13.79 + 0.73	20.76 + 1.71
19	Defenders	6	7.97 + 0.19	9.51 + 0.41	13.10 + 0.56	20.67 + 1.63
	Midfielders	11	8.08 + 0.29	9.48 + 0.36	13.47 + 0.52	20.11 + 1.31
	Attackers	12	7.99 + 0.31	9.53 + 0.47	13.96 + 1.18	20.79 + 2.46
	Total	29	8.02 + 0.28	9.51 + 0.41	13.59 + 0.90	20.51 + 1.86

The descriptive results presented by age are illustrated in Table 2.3. Height, lean body mass, and hours of soccer practice per week increased with age.

Table 2.3 Mean scores (SD) of talented soccer players on anthropometrics, soccer experience and practice hours, presented by age

Age	n	Height (m)	n	Weight (kg)	n	Body fat %	n	Lean body mass (kg)	n	Cum. Soccer years	n	Soccer practice/week (hrs)	n	Additional practice/ week (hrs)
12	24	1.50 + 0.08	24	38.55 + 7.44	24	8.66 + 3.16	24	35.09 + 5.94	23	5.96 + 1.20	24	5.75 + 0.53	24	2.79 + 2.98
13	43	1.58 + 0.09	43	46.32 + 9.60	43	8.09 + 2.33	43	42.48 + 8.44	45	7.14 + 1.09	45	6.01 + 0.81	44	3.20 + 2.95
14	83	1.64 + 0.08	82	50.73 + 9.59	83	8.87 + 4.46	81	46.82 + 7.16	84	7.55 + 1.56	84	6.32 + 0.88	83	3.08 + 2.74
15	95	1.71 + 0.07	95	59.24 + 7.90	94	8.72 + 2.89	94	53.98 + 7.02	94	7.99 + 1.98	91	6.61 + 1.02	89	2.79 + 2.78
16	82	1.75 + 0.07	82	65.21 + 7.01	82	9.59 + 3.51	82	58.91 + 6.33	82	9.20 + 1.77	80	7.67 + 1.37	79	2.89 + 3.29
17	83	1.76 + 0.07	83	67.77 + 7.62	83	8.42 + 2.84	83	61.98 + 6.56	76	9.92 + 2.06	75	7.72 + 1.38	74	1.96 + 1.80
18	60	1.78 + 0.07	60	71.37 + 6.86	60	7.43 + 2.90	60	66.00 + 6.01	57	11.50 + 1.61	56	8.53 + 2.13	57	2.03 + 2.26
19	28	1.78 + 0.05	28	73.14 + 6.85	28	9.19 + 2.47	28	66.35 + 5.62	25	12.10 + 1.58	20	8.68 + 2.68	19	3.13 + 4.89

Table 2.4 The relationships between performances on the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test

Relationship assessed	Pearson correlation (r)	p value
Shuttle sprint and Slalom sprint	0.491	< 0.001
Shuttle dribble and Slalom dribble	0.223	< 0.001
Shuttle sprint and Shuttle dribble	0.542	< 0.001
Slalom sprint and Slalom dribble	0.381	< 0.001

The correlations between the two field tests and between sprinting and dribbling within each test are shown in Table 2.4. According to the guidelines for correlations (Hinkle, Wiersma, & Jurs, 1979), the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test were weakly correlated, although the correlation for sprinting was stronger than that for dribbling. A moderate correlation between sprinting and dribbling was observed for the Shuttle Sprint and Dribble Test. The Slalom Sprint and Dribble Test showed a weak correlation between sprinting and dribbling.

Output estimates for the prediction models of the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test that included age as an independent factor (Level 1) are presented in Figures 2.3 and 2.4. Both tests show an improvement in sprinting and dribbling from ages 12 to 19 ($p < 0.001$). Output estimates for the prediction models of the Shuttle dribble and Slalom dribble are displayed in Table 2.5 and Table 2.6. The deviance shows that the model with the Level 1 parameters, age (as a continuous variable), lean body mass, and hours of total practice per week (soccer and additional hours) significantly improves the model for Shuttle dribble ($p < 0.05$). The other Level 1 parameters (height and cumulative years of soccer experience) and the Level 2 parameter (playing position) do not create a stronger model ($p < 0.05$). The best model for Shuttle dribble is expressed by the following equation: dribble performance on Shuttle dribble (in seconds) = 11.99 – 0.10 x age – 0.01 x lean body mass – 0.02 x hours of total practice per week. Hence the development of dribbling as measured with the Shuttle Sprint and Dribble Test can be predicted with the multi-level model. For instance, it is predicted that talented boys will improve 0.10 s every year independently of their training hours and increase in lean body mass. Total training hours accounts for 0.02 s per hour, for example boys who practice 10 h will improve another 0.20 s a year according to the multi-level model.

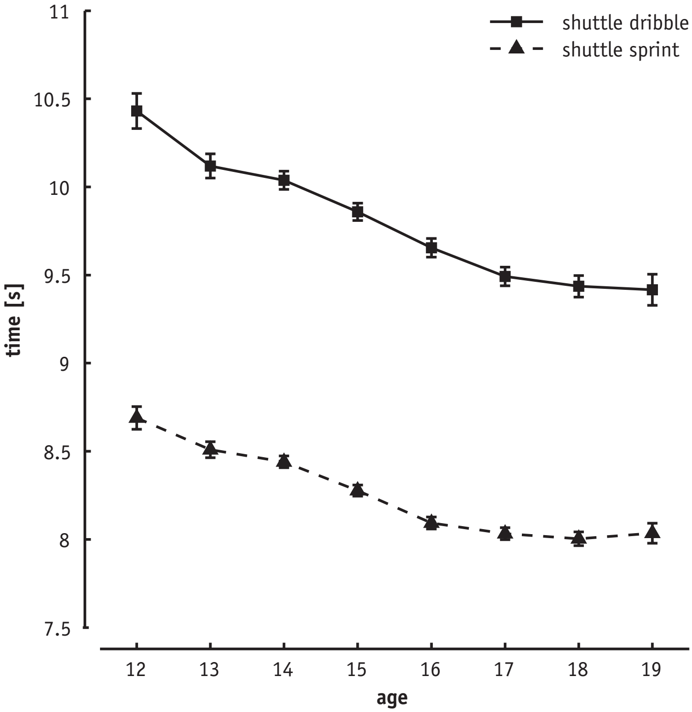

Figure 2.3 Estimated scores (± 1 standard error) for the development of dribbling on the Shuttle Sprint and Dribble Test in talented soccer players. Significant differences, Shuttle sprint (p < 0.05): age 12 vs. ages 14-19, age 13 vs. ages 15-19, age 14 vs. ages 15-19, age 15 vs. ages 16-19. Significant differences, Shuttle dribble (P < 0.05): age 12 vs. ages 14-19, age 13 vs. ages 15-19, age 14 vs. ages 16-19, age 15 vs. ages 17-19.

For the Slalom dribble, the Level 1 parameters of age (as a continuous variable) and hours of soccer practice per week create a significantly stronger model ($p < 0.05$). The Level 2 parameter, playing position, also improved the model significantly ($p < 0.05$). Midfielders' performance was significantly faster than that of attackers and defenders. The best model for defenders on the Slalom dribble is expressed by the following equation: dribble performance on Slalom dribble (in seconds) = 25.85 – 0.19 x age – 0.16 x hours soccer practice per week. For midfielders, the strongest model is the same model as for the defenders minus 0.80 s. The attackers' best predicted model is the defenders' model minus 0.22 s. The development of dribbling as measured with the Slalom Sprint and Dribble Test can also be predicted with the multi-level model. For instance, it is predicted that talented boys will improve 0.19 s each year independently of their training hours and improve 0.16 s per hour of soccer practice. This indicates that soccer practice accounts for a great proportion of the development of the improved Slalom dribble, taking into account the multiple hours of soccer practice a player experiences per week (Table 2.6).

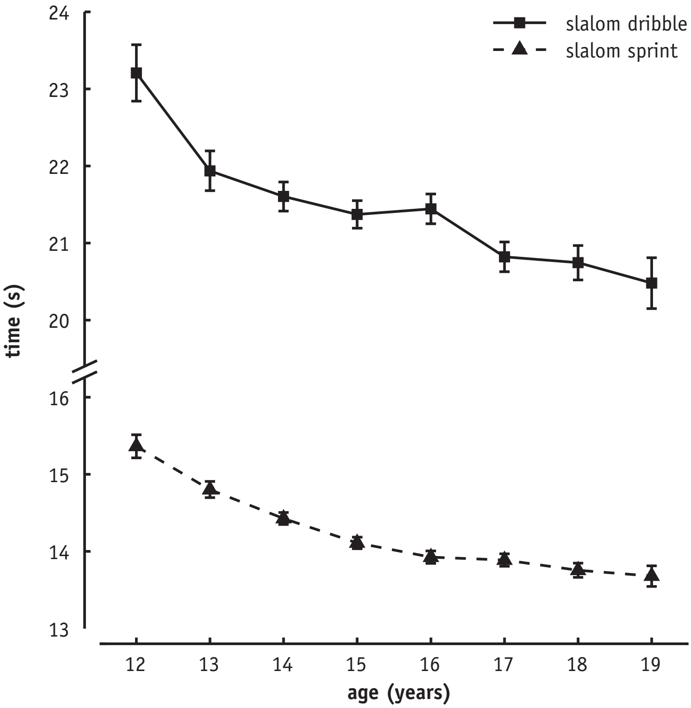

Figure 2.4 Estimated scores (± 1 standard error) on the development of dribbling on the Slalom Sprint and Dribble Test in talented soccer players. Significant differences, Slalom sprint ($p < 0.05$): age 12 vs. ages 13-19, age 13 vs. ages 15-19, age 14 vs. ages 15-19. Significant differences, Slalom dribble ($p < 0.05$): age 12 vs. ages 14-19, age 13 vs. ages 17-19

Table 2.5 Multilevel model for the Shuttle Dribble Test

Fixed effects	Coefficient	Standard error	*P*
Intercept (constant)	11.99	0.23	<0.001
Age	–0.10	0.02	<0.001
Lean body mass	–0.01	0.00	<0.001
Total hours of practice/wk	–0.02	0.01	0.030
Deviance	654.5		
Deviance, only age as factor	753.6		
Deviance from empty model	873.0		

Table 2.6 Multilevel model for the Slalom Dribble Test

Fixed effects	Coefficient	Standard error	*P*
Intercept (constant)	25.85	0.73	<0.001
Age	−0.19	0.06	0.001
Hours soccer practice/wk	−0.16	0.06	0.012
Defender	0	0	
Midfielder	−0.80	0.21	<0.001
Attacker	−0.22	0.21	0.304
Deviance	1914.4		
Deviance, only age as factor	2096.4		
Deviance from empty model	2130.3		

Discussion

The results of this longitudinal study highlight the development of sprinting and dribbling in talented soccer players aged 12-19 years, as measured by two separate tests, the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test. We first examined the correlations between the two tests and the correlations within each test (i.e. between dribbling and sprinting). A low-to-moderate correlation (sprinting: $r = 0.49$; dribbling: $r = 0.22$) was found between the two tests, indicating that they are related, but also measure dissimilar qualities for sprinting and dribbling. The correlation between dribbling and sprinting showed low-to-moderate relationships (Shuttle Sprint and Dribble Test: $r = 0.54$; Slalom Sprint and Dribble Test: $r = 0.38$), indicating that high-speed players are not necessarily the best dribblers. We then examined the development of sprinting and dribbling in talented youth soccer players aged 12-19 years. The results showed improved development of sprinting and dribbling over the years, most marked from ages 12 to 14. However, the speed of development on the Slalom Sprint and Dribble Test is different for dribbling and sprinting: unlike dribbling, sprinting improves rapidly from ages 14 to 16. By contrast, after age 16 dribbling improves considerably but sprinting improves little. Finally, we examined factors predicting dribble performance. The factors that were found to contribute to dribble performance were advanced age, lean body mass, hours of practice, and playing position.

The first part of the study showed low-to-moderate correlations between the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test, illustrating that the two tests are correlated but measure distinct qualities. The Shuttle Sprint and Dribble Test measures primarily the acceleration of soccer players, because the players have to turn 180° three times, accelerating each time from zero velocity (Draper & Lancaster, 1985). The Slalom Sprint and Dribble Test measures the more soccer-specific action of deceiving an opponent by sprinting or dribbling with quick changes of direction (Reilly, 2005). Previous studies have reported low-to-moderate correlations between straight sprint tests and various changes-of-direction tests. A correlation of 0.47 has been reported for straight sprint compared with the Illinois agility test (Draper & Lancaster, 1985), and a correlation of 0.55 between the T-test and 40-yard straight sprint (Pauole, Madole, Garhammer, Lacourse, & Rozenek, 2000). These results are in line with the moderate correlation of the Shuttle sprint and the Slalom sprint (r = 0.49) in the present study. However, the correlations for dribbling are lower (r = 0.22) than for sprinting, indicating that the dribbling tasks are more distinct from each other, needing distinct technical skills for each test. In addition, within each separate test we assessed whether the best sprinters were also the technically most gifted players. The Shuttle Sprint and Dribble Test showed a moderate relationship between sprinting and dribbling (r = 0.54), indicating that some quick sprinters also showed good dribbling performance. The correlation on the Slalom Sprint and Dribble Test was low (r = 0.38), indicating that high-speed players are not necessarily the best dribblers. The Slalom Sprint and Dribble Test has a total of 12 relatively sharp changes of direction, compared with only three changes of direction in the Shuttle Sprint and Dribble Test. Execution of the multiple changes of direction while dribbling is more challenging than dribbling with only three changes of direction, and requires players to adopt a more sideways leaning posture to successfully change direction at high speed (Young et al., 2001).

The second part of the current study illustrated, by using the age model, the improvement in sprinting and dribbling from ages 12 to 19. This improvement is expected because high-intensity activities during match-play also increase with age for young players (Pereira et al., 2007). The changes for sprinting and dribbling were different, although both improved most rapidly at a younger age (12-14 years). The total percentage of predicted improvement for the Shuttle Sprint and Dribble Test from ages 12 to 19 was 7.5% on sprinting ($p < 0.001$) and 9.7% on dribbling ($p < 0.001$). The total percentage of predicted improvement for the Slalom Sprint and Dribble Test from ages 12 to 19 was 11.0% on sprinting ($p < 0.001$) and 11.8% on dribbling ($p < 0.001$). After age 14, players do not necessarily improve their dribbling in relation to their sprinting. Furthermore, quicker dribbling does not automatically indicate that sprinting speed is improved to the same extent. For example, from ages 14 to 16 the estimated progression of dribbling on the Slalom Sprint and Dribble Test (0.16 s) was small (0.7% improvement), whereas sprinting is estimated to improve (0.50 s) significantly (3.3% improvement). Peak height velocity, the maximum velocity in growth during adolescence, occurs in European boy soccer players around age 14 on average (Malina et al., 2004). This indicates that players improve their speed during and just after peak height but their technical skill on the Slalom Dribble test hardly improves. This phenomenon of temporary decline in performance or disruption of motor coordination is called “adolescent awkwardness” (Butterfield, Lehnhard, Lee, & Coladarci, 2004). The process of maturation does not occur at the same chronological age for all talented soccer players, possibly influencing the performance of individual players, since advanced biological maturity status is associated with slightly better technical performance (Malina et al., 2005). Comparable results were found in Olympic youth soccer athletes. Sprint performance on the T-test (sprinting with changes of direction) significantly improved from age 14 to age 15, but performance on a soccer skill test (including dribbling) did not improve significantly (Vanderford et al., 2004). In addition, the present study illustrated hardly any improvement from ages 16 to 19 on the Shuttle and Slalom Sprint (0.06 s and 0.25 s respectively), in contrast to the Shuttle and Slalom Dribble, which improved 0.24 s and 0.96 s. This demonstrates that no marked improvements in sprinting occurred after age 16, whereas a trend was seen for improvements in the technical skill of dribbling. The trend showed that the largest improvements in dribbling occurred at ages 16-17 in both tests. However, the Shuttle dribble and the Slalom dribble showed no significant improvement from ages 16 to 19, due to a large variation between the players.

The final part of the study investigated whether the development of dribbling can be predicted by a combination of factors. The results showed that age, lean body mass, and hours of total practice per week all contribute to Shuttle dribble performance. Significant contributors of the Slalom dribble were age, hours of soccer practice per week, and playing position. Although our results are in line with expectations, limited data are available on the development of talented youth soccer players. Several studies have reported that time spent in practice is a strong discriminator across levels of skill, with elite youth players spending much more time practising than sub-elite players (Helsen et al., 1998; Ward, Hodges, Williams, & Starkes, 2008). This is similar to the results of the current study, because dribble performance was found to increase with hours of practice. The current study illustrates that lean body mass can determine performance on the Shuttle dribble. Various test batteries have also revealed that athletes who perform better on change-of-direction sprinting tests tend to have a lower percentage body fat (Gabbett, 2002; Meir et al., 2001; Reilly et al., 2000a), and therefore more lean body mass to contribute to speed. Hardly any information exists on dribble performance for various playing positions. However, match analyses of professional players show a trend for midfielders to dribble more than attackers, with defenders dribbling the ball least (Bloomfield, 2007). Previous research on elite young soccer players has also shown that attackers and offensive midfielders sprint more with the ball than players from other positions (Pereira et al., 2007). These match analyses results complement Slalom dribble performance in the present study, whereby midfielders performed the best, followed by attackers and defenders.

On the basis of the results obtained, a distinction can be made between the two tests: the Slalom dribble is a more soccer-specific test. Slalom dribble performance can only be predicted by soccer-specific practice, whereas the Shuttle dribble can also be affected by additional practice. Furthermore, Slalom dribble performance depends on playing position, whereas no significant differences for playing position were found for Shuttle dribble performance. Another difference between these tests is lean body mass, which positively predicts Shuttle dribble performance but not Slalom dribble performance. One could hypothesize that the Slalom dribble is more a test of coordination than the Shuttle dribble test. Previous research showed that greater lean body mass means more muscle mass, and most likely more strength, which has an influence on change-of-direction speed over short distances (Negrete & Brophy, 2000). This is in agreement with the current finding for the Shuttle dribble test, whereas Slalom dribble performance appeared to be affected by other factors.

One of the strengths of the current study is its use of a longitudinal design. Because of their surplus value, longitudinal designs are recommended in which players are monitored over a prolonged period of time (Nieuwenhuis et al., 2002; Reilly et al., 2000b; Williams & Reilly, 2000). Instead of comparing age groups in a cross-sectional fashion, the current study assessed the development of individual players, thus improving our understanding of the factors that contribute to performance development. The factor that influences dribbling performance most is more hours of practice per week, and in addition for the Shuttle dribble additional lean body mass. The multi-level models make it possible to compare the development of a talented young soccer player with the performance curves found, allowing trainers and coaches to assess an individual's performance relative to these curves. Applying the curves, trainers and coaches can determine if player X is performing above or below average for his age and which factors may be responsible. The curves indicate the desired development of talented youth soccer players. Hence, players should improve their sprinting and dribbling rapidly from ages 12 to 14, improve sprinting from ages 14 to 16, and from ages 16 to 19 an additional improvement in dribbling performance is needed to function at the highest level in youth soccer and to remain part of a talent development programme.

An additional strength of the present study is the use of statistical multi-level methods; the key advantage is that various measurements are allowed per player. A shortcoming of the current study was the average low numbers of measurements per player, on average 1.9 measurements per player were taken. Reasons for the low number are drop-out (poor performance), injuries, and no follow-up (testing stopped). The first reason could bias the results, but as such missing data were few (< 15%), the impact will be small. Therefore, assuming that most missing data are random, we expect the current data to provide a good illustration of the development of dribbling in talented young soccer players. Another limitation in the current study is the recording of performance times in the Slalom Sprint and Dribble Test. In contrast with the Shuttle Sprint and Dribble Test, the performances were measured with a stopwatch instead of electronic measuring devices. Therefore, the measurement accuracy of the Slalom Sprint and Dribble Test might be less than that of the Shuttle Sprint and Dribble Test.

The present study investigated the development of sprinting and dribbling and the underlying mechanisms of dribbling among talented youth soccer players aged 12-19. Previous research has investigated sprinting, but the connection between sprinting and dribbling was not addressed. The current study found that there was a moderate relation between sprinting and dribbling on the same test. We also assessed a possible connection between the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test. Both tests showed low significant correlations, indicating some similarity between the tests, yet additionally indicating that the tests measure distinct qualities. The development of sprinting and dribbling showed most rapid improvements from ages 12 to 14. The results showed rapid improvements from ages 14 to 16 on sprinting, but dribbling hardly improved in that age span. However, dribbling appeared to improve further after age 16, while sprinting after that age hardly improved. Finally, factors found to contribute to an excellent performance in dribbling were advanced age, lean body mass (only for Shuttle dribble), and hours of (soccer and additional) practice. Furthermore, playing position distinguishes dribbling performance on the Slalom dribble test. To verify if there is a difference in development of talented young soccer players who ultimately reach professional status, these players are being followed until they reach elite status in adulthood.

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Chapter 3

Improvement in sprinting and dribbling of national Indonesian soccer players (under 23 years)

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Abstract

Aim: This study gained more insight into the relation between improvements on sprinting with and without the ball in a group of national youth soccer players.
Methods: The sprinting and dribbling performances, measured by time scoring, (n = 14) were tested before and after a twelve week intensive training period. Performance changes were analyzed by means of t-tests for paired data. A correlation matrix described the relation between the changes from T1 to T2 on sprinting and dribbling.
Results: The players significantly increased their sprint performance ($p < 0.01$). Furthermore, they showed a tendency of increased dribbling performance, these results were only significant for the repeated dribble performance ($p < 0.05$). The current study indicates that sprinting performance is not directly related to dribbling performance ($r = 0.35$). A moderate relation was found between repeated sprinting and dribbling improvement from T1 to T2 ($r = 0.54$), no relation was found between the peak sprint and dribble performance improvement ($r = 0.26$). The baseline performance level influences the amount of improvement in both sprinting and dribbling, this supports the law of diminishing returns. Players with a higher performance level before the training period did not improve as much as the players with a lower performance level.
Conclusions: Sprinting and dribbling improvements are not directly related to each other, future training programs should contain more specificity and should also be individualized to increase performance improvements.

Keywords: training, motor skills, athletic performance, development, exercise

Introduction

In soccer, the most obvious difference between teams of various skill levels is the intensity of the game with high-speed actions being decisive to the more crucial moments of the game. Earlier studies have demonstrated that sprinting is related to player performance (Di Salvo et al., 2007; Ekblom, 1986; Mohr, Krustrup, & Bangsbo 2005). Sprinting usually only cover short distances at maximal effort (96% of the sprints are shorter than 30 metres), underlining the importance of the start and acceleration phase (Mohr, Krustrup, & Bangsbo, 2003; Reilly, Bangsbo, & Franks, 2000). High-speed actions not only represent straight sprinting, but also skills which are critical to soccer, such as turning, changing pace and sprinting with the ball (dribbling) (Bangsbo, Norregaard, & Thorso, 1991). Based on game analyses, elite soccer players should also focus on recovering rapidly from periods of high-intensity exercise (Bangsbo, 1994; Mohr et al., 2003). Therefore, the players' ability must include performing high-intensity actions (sprinting with and without ball) repeatedly (Mohr et al., 2003).

During adolescence running speed improves (Baxter-Jones, Goldstein, & Helms, 1993; Hansen, Bangsbo, Twisk, & Klausen, 1999) and also the development of intellectual and motor skills leads to improved technical abilities (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007). Earlier studies indicated an increased sprinting performance in talented youth soccer players over the years (Gil et al., 2007; Kukolj, Ugarkovic, & Jaric, 2003; Vaeyens et al., 2006). A few studies also illustrated that dribbling performance develops in talented youth soccer players during adolescence (Gil et al., 2007; Huijgen, Elferink-Gemser, Post, & Visscher, 2009; Kukolj et al., 2003; Vaeyens et al., 2006). These results imply that sprinting and dribbling are improving with age. To some degree these improvements in sprinting and dribbling are affected by growth and maturation (Kukolj et al., 2003, Mohr et al., 2005). Nevertheless, to reach the highest competition levels, access to adequate training during development is necessary (Gravina et al., 2008). It is known that expert performance is strongly determined by the amount of time a person engages in practice activity with the primary goal of improving some aspect of performance, i.e., deliberate practice (Ericsson, Krampe, & Teschromer, 1993).

High-speed actions in soccer require the components acceleration, maximum speed and agility (Little & Williams, 2005). A study with professional soccer players measured acceleration with a 10 m test, maximum speed with a flying 20 m test, and agility with a zig-zag test over 20 m with three 100° turns. In this study it is shown that the relations between all these components are weak ($r < 0.6$). Hardly any research has examined the relation between sprinting and technical elements in sports like sprinting while dribbling the ball (Lemmink, Elferink-Gemser, & Visscher, 2004).

Strength and conditioning programs for soccer require the development of, among other qualities, speed and speed endurance (Kraemer et al., 2004). Earlier research has proven that speed training contributes to better performance in shuttle run sprints and eventually to better match performance (Psotta, Blahus, Cochrane, & Martin, 2005; Sporis, Ruzic, & Leko, 2008; Wragg, Maxwell, & Doust, 2000). It is known that in a relative short period, varying from 5 to 13 weeks, soccer players are able to improve their running speed, by high-quality and high-quantity practice, including besides soccer-specific training, strength and speed training (Kotzamanidis, Chatzopoulos, Michailidis, Papaiakvou, & Patikas, 2005; Ronnestad, Kvamme, Sunde, & Raastad, 2008; Spinks, Murphy, Spinks, & Lockie, 2007; Sporis et al., 2008). Performance improvements as a result of training programs are influenced by the pre-training level of the individual players (Bouchard & Rankinen, 2001). Training programs most often show the largest improvement results in less trained players, they are more likely to improve their performance than higher skilled players, this phenomenon is called the principle of diminishing returns (Farlinger & Fowles, 2008). The majority of existing research has focused on training effects in sprinting tests, but not on training effects in skill tests. As far as the authors are aware of, the only existing study that investigated the effects of training on sprinting with and without ball is executed by Venturelli, Bishop and Pettene (2008). A twelve week coordination-training program with preadolescent soccer players (mean age 11) was conducted. The results showed improved speed over 20 metres, with and without the ball after the twelve week training program. However, it is unknown if increased sprinting performance leads to increased sprinting performance with the ball.

The overall purpose of the current study was to gain more insight into the relation between (improvements on) peak sprinting and repeated sprinting with and without the ball in a group of national youth soccer players (average age 20 years). Sprinting with ball (indicated as dribbling in the current study) and without ball are measured over the same course, over short distances with quick changes of direction. It is investigated if a twelve week intensive training program can improve national youth soccer players' sprinting and dribbling performance and the way in which the changes in sprinting and dribbling are related. Furthermore, it is investigated if differences exist in performance changes over the twelve week period between players with a different performance level at baseline.

Methods

Participants

Participants were 14 players of the Indonesian national youth soccer team. The players were considered to be the top players of their age category in their country. Nevertheless, these players did not have access to optimal training facilities, and a poor competitive structure during their youth and adolescence. Average age of the players was 20.3 years (± 1.4 years) and the average accumulated organized experience of the players was 11.2 years (± 2.4 years) The Indonesian team ranking was 110 on the FIFA World Ranking (2005/2006, FIFA World Ranking, 2008).

Procedures

All players were informed about the procedures of the study before giving their verbal consent to participate. The national soccer federation, trainers, and coaches of the team gave their permission for this study; all procedures were in accordance with the ethics committee standards of the Medical Faculty of the University of Groningen. The data were collected in the Netherlands during their preparation for the qualification tournament for the Asian Games (2006). The training period was conducted under the supervision of highly qualified and internationally successful Dutch trainers and coaches. Date of birth, playing position, and accumulated years of organized soccer experience were administered. The Indonesian team performed two tests, one at the beginning of a twelve week training period and one at the end of the twelve week period. A familiarization testing period took place before the first testing session for the players to become acquainted with the test protocols. The (repeated) sprint and dribble performance was conducted with the Shuttle Sprint and Dribble Test (ShuttleSDT) (Lemmink et al., 2004). The players completed this test on an artificial grass soccer field. Ambient temperature, humidity, and wind conditions were documented during every testing session. In advance of both testing sessions, the anthropometrics (stature, body mass, and percentage body fat) were measured. Stature was measured with a wall-mounted stadiometer and body mass was measured using a digital scale. Body fat percentage was estimated by means of leg-to-leg bioelectrical impedance (BIA) analysis (Valhalla BIA, Valhalla, Inc., San Diego, CA) (Nunez et al., 1997). Lean body mass was calculated by subtracting the percentage of body fat from the total weight of the players. During the complete training period of the Indonesian team, the trainers completed a diary with the amount and type of practice per individual.

Shuttle Sprint and Dribble Test (ShuttleSDT)

The protocol consisted of six maximal sprints of 30 m and six maximal sprints of 30 m while dribbling a soccer ball (Lemmink et al., 2004). The players were allowed a short rest between successive 30 m sprints and dribbles. The length of this rest period depends on how fast the trial is performed: the next trial started exactly 20s after the start of the previous trial. Each 30-m sprint has three 180˚ turns (Figure 3.1). Timing data were measured by means of photoelectric cell gates (TAG Heuer, Eraton BV Digital Timing Equipment, Weert, The Netherlands). Peak sprint or dribble performance is indicated by the time covered in the fastest of six 30 m trials; repeated sprinting or dribbling performance is the total time covered by all six 30 m sprints and dribbles respectively.

The percentage decrement (% DS) in peak sprint and peak dribble performance over the three trials was calculated as follows (Glaister, Stone, Stewart, Hughes, & Moir, 2004):

% DS sprint = 100 – [(peak sprint time x 6/repeated sprint time) x 100]

% DS dribble = 100 – [(peak dribble time x 6/repeated dribble time) x 100]

The ratio of the peak sprint and peak dribble was calculated by dividing the peak dribble time by the peak sprint time. The same method is used to calculate the ratio of the repeated sprint and dribble time. The lower index was assumed to indicate better skill of controlling the ball (Kukolj et al., 2003).

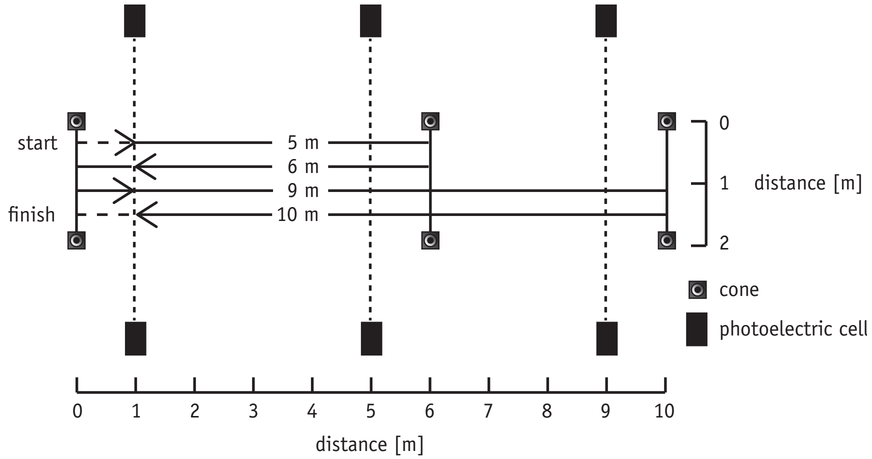

Figure 3.1 Course for ShuttleSDT

Since the ShuttleSDT was primarily developed for field hockey players (Lemmink et al., 2004), psychometry of these tests in soccer players was assessed. The reliability of the ShuttleDT was measured during pilot testing in 20 youth soccer players with an average age of 15.4 years (SD ± 1.9; range 12-19 years) (Huijgen et al., 2009). The pilot testing showed that the ShuttleSDT is also reliable for soccer. The results showed good relative as well as absolute test-retest reliability. Intra Class Correlation (ICC) for the Shuttle Sprint was 0.81 and absolute reliability 0.20 (95% Confidence Interval (CI) 0.12 to 0.52). For the Shuttle Dribble ICC was 0.74 and absolute reliability was 0.02 (95% CI 0.37 to 0.34).

Training diary

For a period of twelve weeks (i.e., in between both test sessions of the Indonesian team) the trainers staff completed a diary with the amount and type of practice for every individual player. The amount was recorded in minutes per type of training. The type of practices were divided in speed (e.g., sprinting, starting, accelerating), technical (e.g., passing, dribbling, shooting), strength (e.g., weight training, plyometrics, circuit training), tactical (e.g., small-sided games, game-play with specific instructions), interval (high-intensity running followed by low-intensity running), and other training (e.g., recovery training). These types of practices were delineated by the scientific team to get insight in the training activities. The average amount and type of practice per week of the Indonesian players between T1 and T2 is presented in Table 3.1. Besides the training program, the players performed one or two practice matches per week.

Table 3.1 Average hours of practice for the Indonesian youth soccer team during the twelve week training period

Type of practice	Average amount of practice per week (Hours)
Speed	1.3 (0.2)
Strength	1.4 (0.2)
Technical	0.8 (0.3)
Tactical	1.5 (0.1)
Interval	0.9 (0.3)
Other	1.4 (0.2)
Total	7.3 (0.9)

Statistical analysis

Results were expressed as means ± standard deviations (M ± SD). To check normality of the variables at T1, skewness and kurtosis variables z-scores were calculated. Results showed z-scores between -1.96 and 1.96. Therefore, the data were considered to be indicative of an approximately normal distribution (Field, 2000). Differences on the consecutive trials for sprinting and dribbling were determined by comparing means using an one-way analysis of variance. Possible differences on peak and repeated sprint and dribble performances, % DS and the ratio dribble/sprint between the first (T1) and second measurement (T2) were determined by t-tests for paired data. Cohen's effect sizes (d) were used for interpretation of small (0.25), medium (0.50) and large (0.80) effects (Cohen, 1988). A correlation matrix illustrated the relation between the changes from T1 to T2 on (repeated) sprinting and (repeated) dribbling. First, the relationships between peak and repeated sprinting and dribbling at T1 were determined. Second, the relation between peak and repeated sprinting and dribbling changes from T1 to T2 were assessed. Finally, the relationships between the ShuttleSDT performances on T1 and the ShuttleSDT performance changes from T1 to T2 were assessed. All possible relationships were determined by Pearson correlations (r). The interpretation of the correlations were based on the following guidelines (Hinkle, Wiersma, & Jurs, 1979): below 0.30 insubstantial correlation; 0.30 to 0.50 low correlation; 0.50 to 0.70 moderate correlation and above 0.70 high correlation (Hinkle et al., 1979). To indicate if a significant difference existed in performance changes, the team was divided into two groups on the basis of peak sprinting performance during baseline by using the median. The two groups (7 players in each group) are compared on their progression from T1-T2. The possible differences in performance changes during the twelve week training period were conducted with an independent samples t-test. An alpha of 0.05 was adopted for all tests of significance.

Results

Anthropometric data from the 14 Indonesian players from baseline (T1) to T2 is presented in Table 3.2. Players' body mass and body fat percentage decreased during the twelve week period, hence their lean body mass increased ($p < 0.05$).

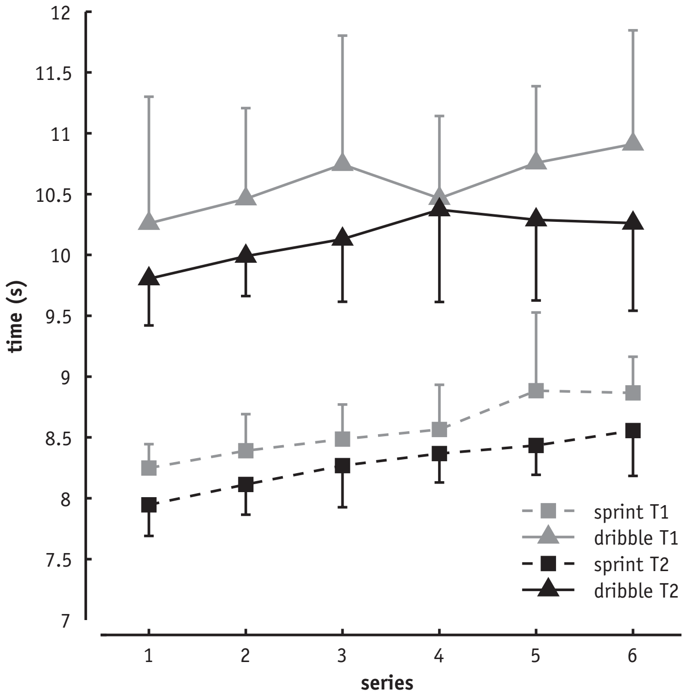

Figure 3.2 Average team results on the 6 trials of the ShuttleSDT before (T1) and after the twelve week training period (T2). Standard deviations (SD) are only illustrated in one direction for clarity, in reality SD's should be illustrated both ways.

Figure 3.2 shows the results for all six sprint and dribble performances at T1 and T2. The results indicate that the first out of the six sprints with or without ball is on average the fastest. The first sprint at T1 and T2 is significantly faster than the second sprint ($p < 0.05$). For dribbling the differences between the first and second trial do not significantly differ (T1: $p = 0.224$ and T2: $p = 0.079$). The sprinting performance decreases on average over the six trials at T1 and T2. Dribbling performance seems to decrease over the consecutive trials as well. Only at T1 the average time of the 4th dribble seems to be faster than the average time on the 3rd dribble but this difference is not significant ($p = 0.218$) and is due to one player who performed his peak dribble during this fourth trial. At T2 the average dribbling performance does not seem to decline after the 4th trial ($p = 0.644$).

Table 3.2 Anthropometrics of the Indonesian youth soccer team at T1 and T2 (mean ± SD)

	T1	T2	*p*
Body mass (kg)	69.9 (4.9)	69.3 (5.1)	0.043
Bodyfat%	12.4 (2.8)	10.4 (2.4)	< 0.001
Lean body mass (kg)	61.2 (4.1)	62.0 (4.1)	0.008

Table 3.3 shows the results for the T1 and T2 performances on the ShuttleSDT, the pre- and posttests are compared with paired t-tests ($n = 14$). The tests indicated that the players

Table 3.3 Results (mean ± SD) on the ShuttleSDT before (T1) and after the twelve week training period (T2)

	T1	T2	*T*	*p*	Effect size (*d*)
Peak 30 m sprint (s)	8.19 (0.23)	7.90 (0.23)	4.96	< 0.001	0.53
Peak 30 m dribble (s)	9.90 (0.53)	9.64 (0.24)	1.86	0.086	0.30
6x 30 m sprint (s)	51.44 (1.71)	49.68 (1.34)	3.79	0.002	0.50
6x 30 m dribble (s)	63.30 (3.80)	60.84 (2.53)	2.44	0.030	0.36
% Decrement sprint (6x)	4.44 (1.71)	4.59 (1.66)	−0.25	0.805	0.04
% Decrement dribble (6x)	6.50 (3.13)	4.86 (2.43)	1.50	0.157	0.28
Ratio peak dribble/sprint	1.21 (0.06)	1.22 (0.05)	−0.70	0.498	0.09
Ratio repeated dribble/sprint (6x)	1.24 (0.06)	1.23 (0.06)	0.26	0.801	0.08

Note: A *Cohen's d* around 0.20 reflects a small, around 0.50 a moderate and around 0.80 a large effect size

show a significant improvement ($p < 0.05$) from baseline (T1) to T2 on peak as well as on repeated (6x) shuttle sprint performance. The dribble test performance tends to improve as well (small effect sizes), however this improvement is only significant for the repeated (6x) dribble test ($p < 0.05$). The decrement in percentage sprint and dribble performance were not significantly different from T1 to T2 ($p > 0.05$). The ratio (repeated) dribble divided by (repeated) sprint performance both do not differ significantly from T1 to T2 ($p > 0.05$).

The correlation matrix is illustrated in Table 3.4. At baseline (T1) peak and repeated sprinting as well as peak and repeated dribbling were highly correlated to each other. Peak sprint and peak dribble performance show a low correlation, while the repeated sprint and repeated dribble showed a moderate relation at baseline. Comparable results are found by comparing the sprint and dribble improvements from T1 to T2. The peak and repeated part of the sprint and dribble improvements respectively, are highly related to each other. Peak sprint and peak dribble improvements show low correlations, while the repeated portions of the sprint and dribble improvements correlate moderately. By comparing the baseline scores with the performance improvements, strong relations were assessed between the repeated sprint baseline score and the repeated sprint improvement. Also high correlations were found between the peak dribble baseline score and the peak dribble improvement. The repeated dribble score at baseline was highly related to the peak and the repeated dribble improvement.

The total group of players is divided in two groups by means of the baseline peak sprint scores, this is illustrated in Table 3.5. The players with the lower sprinting performance score at T1, improved significantly more during the 12 week period on peak dribbling than the players with a higher sprinting performance score at T1 ($p < 0.05$). Also, all other performance changes showed a tendency whereby the players with the lower sprinting performance score at T1 improved more than the players with a higher sprinting performance score at baseline, the results of repeated dribbling are borderline significant.

Table 3.4 Correlation matrix for the Sprint (S) and Dribble (D) times at T1 and the changes (Δ) from T1 to T2

	T1PeakS	T16xS	T1PeakD	T16xD	ΔpeakS	Δ6xS	ΔpeakD	Δ6xD
T1PeakS	1	0.84**	0.35	0.38	0.48	0.58	0.31	0.23
T16xS		1	0.59*	0.62*	0.33	0.70**	0.51	0.39
T1PeakD			1	0.84**	0.41	0.69**	0.90**	0.58*
T16xD				1	0.26	0.61*	0.80**	0.81**
ΔpeakS					1	0.72**	0.26	0.12
Δ6xS						1	0.70**	0.54*
ΔpeakD							1	0.77**
Δ6xD								1

* $p < 0.05$
** $p < 0.01$

Table 3.5 Comparison of the change from T1 to T2 between the best and less performers at T1 within the Indonesian youth soccer team

	T1 peak sprint	Δ T2-T1	t	*p*
Δ T2-T1 Peak 30 m sprint	≥8.29	−0.37 (0.22)	1.37	0.195
	<8.29	−0.21 (0.20)		
Δ T2-T1 Peak 30 m dribble	≥8.29	−0.48 (0.66)	3.62	0.004
	<8.29	−0.04 (0.23)*		
Δ T2-T1 6 x 30 m sprint	≥8.29	−2.74 (1.92)	1.67	0.137
	<8.29	−0.77 (0.76)		
Δ T2-T1 6 x 30 m dribble	≥8.29	−4.92 (3.82)	2.17	0.051
	<8.29	−0.59 (3.12)		

* significant difference with the 'less' performance group

Discussion

The overall purpose of the current study was to gain more insight into the possible relation between improvements on maximum sprinting and repeated sprinting with (dribbling) and without ball in a group of national youth soccer players. The youth soccer players were the best players from Indonesia (average age 20.3 years ± 1.4). Nevertheless, these players did not have access to optimal training facilities, and a poor competitive structure during their youth and adolescence. To improve overall performance, the Indonesian youth team performed a twelve week training period under the supervision of highly qualified and successful Dutch trainers and coaches. To investigate the changes in sprinting and dribbling performance, pre- and posttests were performed measured with the Shuttle Sprint and Dribble Test (Huijgen et al., 2009; Lemmink et al., 2004). The players significantly increased their (repeated) sprint performance, and showed a tendency of increased dribbling performance, however these results were only significant for the repeated (6x) dribble performance. Furthermore, the results of the current study indicate that an improvement in sprinting performance is not directly related to increased sprinting with ball (dribbling) performance.

During the twelve week training period, the peak sprinting performance on the ShuttleSDT of the Indonesian players improved on average 0.29 s. This time difference can be essential to be in time to receive a ball, cover the defense, sprint past an opponent, etc. Also, the players significantly improved their repeated sprint by 1.76 s. Numerous bouts of sprinting and turning are mainly covered by the anaerobic metabolism (Mohr et al., 2005). However, high aerobic capacity is needed to recover from these high activity efforts (Glaister, 2005; Spencer, Bishop, Dawson, & Goodman, 2005). An earlier study indicated that both anaerobic as well as aerobic energy systems contribute to the energy supply during the ShuttleSDT (Lemmink & Visscher, 2006). The sprinting performance results indicate that both the players' anaerobic and aerobic capacity significantly improved over the twelve week training period. Our results are in line with previous research, various studies addressed increased sprinting performances after short-term training programs (Kotzamanidis et al., 2005). Dribbling performance showed an improvement over the twelve week training period, however, the improvement on the peak dribble performance was not significant. A reason for the lack of significant improvement in peak dribbling might be the age of the Indonesian national youth team players. Earlier research has suggested that in the early years of development (up to puberty) a greater change exist in development of motor skills than after puberty (Reilly et al., 2000). Since dribbling requires more complex motor skills than sprinting, it is not surprising that dribbling shows less improvement at age 20 than sprinting. Nevertheless, the average dribbling improvement was 0.26 s which may be relevant, since this time difference might be essential in match play in winning possession of the ball, dribbling around an opponent, or scoring a goal (Bangsbo, 1994; Reilly et al., 2000). Repeated dribbling performance (6x) showed a significant improvement, illustrating less variation in the successive dribbles at T2 compared to T1. This indicates less 'errors' under fatigue. Earlier research has also indicated that the execution of technical skills following effects of fatigue, can cause an increase in playing errors (Lyons, Al-Nakeeb, Nevill, 2006; Mohr et al., 2003). Therefore, the players' ability must include performing high-intensity dribbles repeatedly (Lyons et al., 2006; Mohr et al., 2003). The Indonesian players showed increased ball control, also under fatigue, over the 12-week training period and hence the players showed more effective handling of the ball. The only study, as far as the authors know, that investigated the effect of training on sprinting with and without ball was executed by Venturelli et al. (2008). The difference between both studies was the age of the subjects, 20 years in the current study versus 11 in the earlier study. In addition, the test conducted in Venturelli's study did not include changes of direction, in contrast to the ShutttleSDT in our study. Venturelli et al. found that coordination training significantly improved the sprinting with ball performance after twelve weeks, this in contradiction to solely sprint training. Only sprint training did not improve the sprinting with ball performance over twelve weeks (Venturelli et al., 2008). In the present study all players completed the same training program. The training program was carefully composed, containing all elements that are needed to improve overall soccer performance and therefore also sprinting and dribbling.

Earlier studies have not examined the relation between sprinting with and without the ball in soccer-specific tests in talented or elite soccer players. The present results during baseline testing showed that the peak performance and repeated performance of sprinting, respectively dribbling are highly correlated with each other. This indicates that the players who showed high peak performance (with and without ball) were also able to repeatedly execute the sprint with and without ball. The relation between peak sprinting and peak dribbling is low, while the relation between repeated sprinting and dribbling is moderate. This indicates that the fastest sprinters are not the fastest at the dribbling task. A suggestion for this finding might be that dribbling relies on a different mechanism than sprinting. Not only the anaerobic system is used for peak dribbling, but to execute the dribbling task the coordination system is also more appealed. The repeated sprints and dribbles show a stronger relation than the peak sprint and peak dribbles, this is probably due to the larger role of the aerobic system in energy contribution. The correlations found in the current study between peak and repeated sprinting, and respectively between peak and repeated dribbling are in line with earlier research conducted by field hockey players on the ShuttleSDT (Lemmink et al., 2004). The current study showed that the improvements within sprinting and dribbling are highly related to each other. The improved peak sprint (or dribble) performance showed a high correlation with improved repeated sprint (or dribble) performance after the twelve week training program. However, the improvement on peak sprinting showed a low correlation with the peak dribbling improvement. The repeated sprint and repeated dribble improvement were moderately correlated. This indicates that improvement in sprinting performance is not directly related to the dribbling performance improvement. All players underwent the twelve week training program engaging in identical activities, nevertheless, specific technical and tactical training might have been dissimilar for the different positions, in addition every individual can experience identical practices different (Bouchard & Rankinen, 2001).

The results in the current study suggest that improvement in sprinting does not indicate the same improvements in dribbling over the same course. The baseline score of the sprint, respectively the dribble was highly correlated with the improvement times, this indicated that baseline performance level influences the extent of improvement. This is in agreement with the results in the current study. It is indicated that not all 14 players of the Indonesian team improved to the same extent during the twelve week training period. Comparing the improvement of the players with a lower and higher sprinting performance score at T1 with each other, showed that the high performance sprinters did show less improvement than the players with lower sprinting performance scores. The players with a lower sprinting performance level at the start of the twelve week training period did improve their (repeated) sprinting and dribbling performance enormously. This underlies that pre-training level influences the internal load imposed on the individual and, consequently, the training outcome (Farlinger & Fowles, 2008). Therefore, future training programs should differ between individuals with a higher and lower baseline performance. Also, to attribute the performance outcomes to the training program, future research should not only take into account the external training load, but also the internal load (Impellizzeri, Rampinini, Marcora, 2005) as every individual can experience identical practices different.

The results indicate that the players showed significant improvements on sprinting performances, but not on peak dribbling performances. A possible reason for this finding is that the training program was not specific enough for improving dribbling performance. On average, 11% of the training sessions per week were dedicated to technical training, in contrast 18% to speed training and 12% for interval training. This indicates that more time was spent in training speed (endurance) compared to technical skill training, including the specific skill dribbling. A recommendation to increase dribbling performance over 12 weeks would be to include a larger portion of the training week to training on the specific technical skill dribbling and consequently improving the players' coordination. This underlies the principle of specificity, a principle of training that is fundamental for securing optimal adaptation and improving performance (Reilly, Morris, Whyte, 2009). In addition to earlier knowledge and the results found in the current study another recommendation for training programs is to individualize the training programs, including individual exercise prescriptions related to the baseline performance level of the players. During the twelve week training period the players increased in body mass and lean body mass, hence their body fat percentage decreased. Various test batteries also revealed that athletes who perform better on change-of-direction sprinting tests tend to have a lower percentage of body fat (Meir, Newton, Curtis, Fardell, & Butler, 2001; Reilly, Williams, Nevill, & Franks, 2000), and therefore more lean body mass to contribute to speed. A larger capacity of lean body mass, stands for more muscle mass, and most likely more strength. It appears that strength has an influence on change of direction speed over short distances (Negrete & Brophy, 2000). Thus, the improved performances on sprinting and dribbling in the current study might be attributed to the training period, partly due to an increase in muscle tissue.

Conclusions

The national youth soccer players improved (repeated) sprinting and dribbling performances during a twelve week training period. The results indicated that peak sprinting and dribbling performances are not related to each other. Also the peak sprinting and dribbling improvements showed low correlations. Therefore, sprinting and dribbling stress different systems responsible for high-performance and therefore training programs should include more specificity. The repeated sprinting and repeated dribbling performances are somewhat more related. It is indicated that the performance level at the beginning of the training period determines the degree of improvement. Players with a higher performance level before the training period did not improve as much as the players with a lower performance level. Therefore, future training programs should be more individualized and specific to increase performance improvements. Hardly any research is conducted regarding improvement of specific technical skills after training programs. By means of the ShuttleSDT, sprint and dribble performances with quick changes of direction, relevant for soccer players can be easily recorded. Therefore, the ShuttleSDT can assist coaches to easily administer if performance gains in soccer players occurred after a training period.

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Chapter 4

Soccer Skill Development in Professionals

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Abstract

The purpose of this study was to investigate the relationship between the development of the technical skill dribbling during ages 14 to 18 and adulthood playing level. The results gained insight in the required level of the technical skill dribbling during adolescence to be capable of becoming a professional soccer player. Talented players (n = 131), aged 14-18 were measured while they were part of a developmental soccer program, testing took place annually. The players were identified as professional (n = 54) or amateur (n = 77) later on in their career (age > 20). In total 238 measurements of dribbling performance were assessed by means of the Shuttle Dribble Test. A longitudinal model estimated the development for optimal dribbling performance (peak dribbling) and for dribbling performance under fatigue (repeated dribbling), for players ultimately reaching professional status and for players reaching amateur status. The longitudinal results showed that during adolescence the talented players who ultimately became professionals were on average 0.3 seconds faster on 30 m peak dribbling performance and on average 1 second faster on 3 x 30 m repeated dribbling performance than the players who ultimately turned amateur (p = 0.001). It is concluded that during adolescence dribbling performance can assist in identifying the best players for the future.

Introduction

Soccer is a high-intensity intermittent, dynamic sport involving skilled movements (Bloomfield, Polman, & O'Donoghue, 2007; Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001; Mohr, Krustrup, & Bangsbo, 2003). For the more crucial moments of a match, like winning possession of the ball, dribbling around an opponent, or scoring a goal, technical skills are considered critical to performance in soccer (Bangsbo, 1994; Reilly, Bangsbo, Franks, 2000; Rienzi, Drust, Reilly, Carter, & Martin, 2000). Consequently, the velocity and accuracy of dribbling are of great importance in those crucial moments of the game. It is therefore not surprising that the development of dribbling, sprinting while keeping control over the ball, is recognized as a central component in the development of young players (Malina et al., 2005; Reilly, Williams, Nevill, & Franks). The majority of dribbling actions involve acceleration, because players commonly cover short distances (Bangsbo, 1994; Bangsbo, Mohr, Krustrup, 2006; Cometti et al., 2001, Di Salvo et al., 2007). Dribbling regularly involves changes of direction (Young, McDowell, & Scarlett, 2001) which also require acceleration and deceleration. Based on game analyses, talented youth soccer players should also focus on recovering rapidly from periods of high-intensity exercise (Bangsbo, 1994; Mohr et al., 2003). The execution of technical skills following effects of fatigue, can cause an increase in playing errors (Lyons, Al-Nakeeb, & Nevill, 2006; Mohr et al., 2003). Therefore, the players' ability must include performing high-intensity dribbles repeatedly (Mohr et al., 2003). In the current study, the optimal performance of the technical skill dribbling is tested as well as dribbling under fatigue.

During adolescence, technical soccer skills, such as dribbling, improve because of the development of intellectual and motor skills (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007). Earlier studies demonstrated an improved dribbling performance during adolescence in talented youth soccer players (Malina et al., 2005; Reilly et al., 2000; Vaeyens et al., 2006). However, only a small percentage of the so labelled talents ultimately reach the highest level in soccer. Therefore, to optimize talent identification and talent development, it is necessary to classify important indicators, such as technical skills, needed for talented players that can assist in predicting success during adulthood. Monitoring the technical development of talented soccer players over a prolonged period of time by means of longitudinal research can contribute to an improved understanding and enhance the talent identification and selection process. Estimating performance models by means of longitudinal measurements is a useful tool in hypothesizing future playing level of talented soccer players on the basis of their performance level and development during adolescence. Until now, as far as the authors know, it is still unknown what level of dribbling performance and dribbling development is necessary during adolescence to reach the top in professional soccer. Consequently, a large group of all talented youth soccer players should be followed until adulthood to make it possible to discriminate between players who are ultimately more or less successful (Reilly, Bangsbo, & Franks, 2000; Williams & Reilly, 2000). Therefore, the goal of this study was to investigate the relationship between the development of the technical skill dribbling during ages 14 to 18 and adulthood playing level (i.e., professional versus amateur). In addition, this study gained insight in the required level of the technical skill dribbling during adolescence to be capable of becoming a professional soccer player.

Methods

Participants

Talented youth soccer players from two talent development programs of Premier league soccer clubs, i.e. soccer schools in the Netherlands, participated in the longitudinal study. From 2001 to 2007, measurements were taken annually, with the exception of 2004, resulting in six measurement occasions. The players, who reached adulthood (20 years or older in 2008) were analyzed in the current study. This resulted in 238 measurements with a total of 131 players. The players competed at the highest level during adolescence, which consists of the best 0.5% of the total number of Dutch soccer players in their age group (National Soccer Association KNVB). The distribution of measurement occasions per player and per age group for adulthood playing level is reported in Table 4.1.

Professionals are identified as players who are playing in the selection of a Premier league club, or in the first team of the first division of the national league. Amateurs are identified as players who play for an amateur club (second division national league or lower). Although players returned each year, they were not measured exactly the same time each year. Because of this, the age of the players was recorded in months at the time of measurement to create standardized age groups. I.e., a 14-year old player was defined as a player tested within the age range 13.50-14.49 years. Table 4.2 shows the general characteristics of the players per age group, divided by adulthood playing level.

Table 4.1 Number of measurements per player per age category and adulthood playing level

Age	Adulthood playing level	Number of measurements				
		1	2	3	4	Total
14	Professionals	0	2	7	2	11
	Amateurs	3	10	1	1	15
15	Professionals	2	3	14	2	21
	Amateurs	12	14	4	1	31
16	Professionals	1	5	10	1	17
	Amateurs	7	14	7	1	29
17	Professionals	6	8	15	1	30
	Amateurs	7	13	6	0	26
18	Professionals	10	10	11	2	33
	Amateurs	9	9	6	1	25
Total measurements		57	88	81	12	**238**
Number of players		57	44	27	3	**131**
	Professionals	19	14	19	2	**54**
	Amateurs	38	30	8	1	**77**

Table 4.2 Mean scores (SD) on anthropometrics, cumulative years of soccer experience, and hours of practice of talented soccer players presented by age and adulthood playing level

Age	Adulthood playing level	n	Height (m)	Weight (kg)	% Body Fat	Lean body mass (kg)	Cumulative years of soccer experience	Hours of soccer practice/wk	Hours of additional practice/wk
14	Professional	11	1.69 (.08)	57.0 (6.7)	9.2 (2.5)	51.8 (6.1)	7.6 (1.6)	6.7 (.8)	4.2 (2.6)
	Amateur	15	1.64 (.11)b	49.7 (7.9)b	9.3 (2.5)b	45.1 (7.6)b	7.5 (1.9)	5.8 (1.1)	2.9 (1.7)
15	Professional	21	1.73 (.07)a	61.5 (8.6)a	8.7 (3.0)a	56.1 (7.7) a	8.4 (1.7)	6.8 (.8)a	2.3 (2.6)a
	Amateur	31	1.69 (.08)c	57.2 (8.2)c	9.8 (3.0)c	51.5 (7.0)c	8.2 (2.0)	6.3 (1.0)a	3.9 (3.0)a
16	Professional	17	1.75 (.08)	65.4 (8.9)	11.0 (4.6)	58.3 (9.0)	9.0 (1.7)	7.7 (1.7)	2.7 (2.6)
	Amateur	29	1.75 (.05)a	65.5 (6.0) a	10.6 (3.2)a	58.5 (4.6)a	9.1 (1.7)	6.8 (1.1)c	3.3 (2.9)c
17	Professional	30	1.76 (.07)	69.0 (7.5)	8.9 (3.1)	62.8 (6.5)	10.6 (1.5)c	7.4 (.9)c	2.2 (1.7)c
	Amateur	26	1.75 (.06)	67.5 (5.9)	8.1 (2.3)	61.9 (4.9)	9.2 (2.5)	7.0 (1.3)a	2.0 (1.8)a
18	Professional	33	1.80 (.08)b	73.8 (8.7)b	7.6 (2.3)c	67.9 (7.9)c	11.7 (1.9)b	9.3 (2.4) c	1.9 (2.4)c
	Amateur	25	1.77 (.05)b	69.5 (6.1)b	6.8 (2.9)b	65.2 (5.0)b	11.7 (1.7)b	7.7 (1.7)c	2.0 (2.2)b

a One missing value
b Two missing values
c Three missing values

Procedures

All players were informed about the procedures of the study before giving their verbal consent to participate. The clubs and the trainers gave permission for this study. The procedures were in accordance with the ethical standards of the Medical Faculty of the University of Groningen. The players completed the Shuttle Dribble Test on a(n) (artificial) grass soccer field. The testing occurred in separate testing sessions, during the players' regular training hours, varying between 15:30h and 18:30h. The measurements took place at the end of the competitive season, which generally varied from March to May; this resulted in well-trained players who participated in a program of intensive practice at the soccer school. Ambient temperature, humidity and wind conditions were documented; it was attempted not to let them vary too much across occasions. The anthropometrics of height, weight, and percentage body fat were measured. The latter was estimated by means of leg-to-leg bioelectrical impedance (BIA) analysis (Valhalla BIA, Valhalla, Inc., San Diego, CA). Date of birth, position in the field, cumulated years of soccer experience, hours of soccer practice, and hours of additional practice were also administered.

Shuttle Dribble Test (ShuttleDT)

This soccer-specific test consisted of three maximal sprints of 30 m while dribbling a soccer ball (Lemmink, Elferink-Gemser, & Visscher, 2004). Dribbling in the current study was quantified as a performance measure of speed while controlling the ball in changing directions (180˚). The players were allowed a short rest between successive 30 m dribbles. The length of this rest period depends on how fast the dribble is performed: the next dribble started exactly 20 s after the start of the previous dribble. Each 30 m dribble has three 180˚ turns which the players have to cross with both feet and the ball (Figure 4.1). The players were instructed to control the ball while performing the test. Timing data were measured by means of photocell gates (Eraton BV, Weert, The Netherlands) placed at 1.05 m above ground (approximately at hip height). Peak dribbling performance is indicated by the time covered in the fastest of three 30 m dribbles; repeated dribble performance is the total time covered by all three 30 m dribbles.

Since the ShuttleSDT was primarily developed for field hockey players (Lemmink et al., 2004), psychometry of this test in soccer players was assessed. The reliability of the ShuttleDT was assessed during pilot testing of 20 youth soccer players with an average age of 15.4 years (SD ± 1.9; range 12-19 years). Players were tested twice with two days between the first and second measurement. The results showed good relative as well as absolute test-retest reliability. Reliability for peak shuttle dribble performance ICC was 0.74 and absolute reliability -0.02 (95% CI -0.37 to 0.34). Reliability for the repeated shuttle dribble performance ICC was 0.83 and absolute reliability 0.24 (95% CI -0.73 to 1.21).

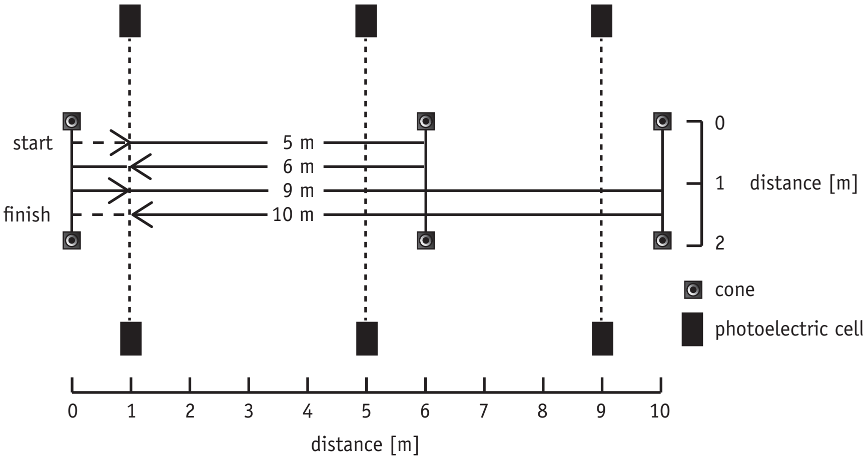

Figure 4.1 Course for the ShuttleSDT

Statistical analysis

SPSS version 14.0 (SPSS, Inc. Chicago, IL, 2005) was used for the statistical analyses. Descriptive statistics were illustrated by means of error bar plots for both peak and repeated dribbling performance. The error bar plots showed the mean ± 1 Standard Error (SE) for both adulthood playing levels at every age. The peak and repeated dribbling performance mean scores, standard deviation, mean difference and 95% Confidence Interval of the difference between amateurs were calculated per age group. Levene's test was used to test for equality of variances.

Longitudinal changes in the ShuttleDT were investigated by multilevel models using the linear-mixed model procedures. Multilevel models can handle data which are not independent, as is the case in a longitudinal design. The advantage of multilevel models is that the number of measurements and the temporal spacing of measurements may vary between players, assuming that the missing data are at random (Landau & Everitt, 2004; Peugh & Enders, 2005; SPSS, 2005) The multilevel analysis created models of the dribbling performances (peak and repeated) that included age and adulthood playing level as independent factor. Random intercepts and random slopes were considered, allowing a unique intercept for each individual player and properly accounting for correlations amongst repeated measures within individual players (Peugh & Enders, 2005). The model fit was evaluated by comparing the -2 Log Likelihood (deviance) of the empty model, with the final model. An alpha of 0.05 was adopted for all tests of significance.

Results

Descriptive statistics of the peak shuttle dribble performance are shown in Table 4.3. Table 4.4 shows the descriptive statistics of the repeated dribble performance. The mean differences between adulthood playing level indicate that current professionals were faster than current amateurs during every age on the ShuttleDT.

Table 4.3 Mean scores (SD), mean difference and 95% CI of the difference on the Peak Shuttle Dribble presented by age and adulthood playing level

Age	Adulthood playing level	n	Peak Shuttle Dribble (s)	Mean difference (s)	95% CI of the difference
14	Professional	11	10.08 (.69)	0.18	−0.32 – 0.67
	Amateur	15	10.26 (.42)		
15	Professional	21	9.79 (.43)	0.41	−0.16 – 0.65
	Amateur	31	10.20 (.42)		
16	Professional	17	9.65 (.56)	0.41	−0.08 – 0.91
	Amateur	29	10.06 (.91)		
17	Professional	30	9.41 (.38)	0.25	−0.02 – 0.48
	Amateur	26	9.66 (.48)		
18	Professional	33	9.33 (.50)	0.09	−0.16 – 0.34
	Amateur	25	9.42 (.44)		

Table 4.4 Mean scores (SD), mean difference and 95% CI of the difference on the Repeated Shuttle Dribble presented by age and adulthood playing level

Age	Adulthood playing level	n	Repeated Shuttle dribble (s)	Mean difference (s)	95% CI of the difference
14	Professional	11	31.77 (1.68)	1.43	−0.05 – 2.82
	Amateur	15	33.20 (1.70)		
15	Professional	21	30.57 (1.39)	1.53	−0.45 – 2.62
	Amateur	31	32.11 (2.19)		
16	Professional	17	30.47 (2.40)	1.35	−0.17 – 2.87
	Amateur	29	31.82 (2.51)		
17	Professional	30	29.68 (1.75)	1.10	−0.20 – 2.40
	Amateur	26	30.78 (3.03)		
18	Professional	33	29.79 (1.70)	0.32	−0.66 – 1.30
	Amateur	25	30.11 (2.04)		

The descriptives are also illustrated in Figure 4.2 for the peak shuttle dribble and Figure 4.3 for the repeated shuttle dribble. The error bar plots in both figures show the mean ± 1 SE for both adulthood playing levels at every age. The results indicate that both groups improve their performance by increasing age.

The estimated models of the peak and the repeated shuttle dribble for professionals compared to amateurs that included age as independent factor are presented in Table 4.5 and 4.6. Both models show that age and adulthood playing level significant influence the model. Age as factor and age as continuous variable showed the same model fit. However, it is chosen to include age as factor, to indicate the development over ages. The interaction between age and adulthood playing level is not significant ($p > 0.05$), and is therefore not included in the models. Also, the random slopes did not improve model fit. At all ages the current professionals were estimated to perform 0.26 seconds better on the peak ($p = 0.001$) and 1.07 seconds faster on the repeated dribble ($p = 0.001$) than current amateurs. The level 2 variance of 0.03 seconds for the peak and 1.16 seconds for the repeated dribble indicates the differences between players.

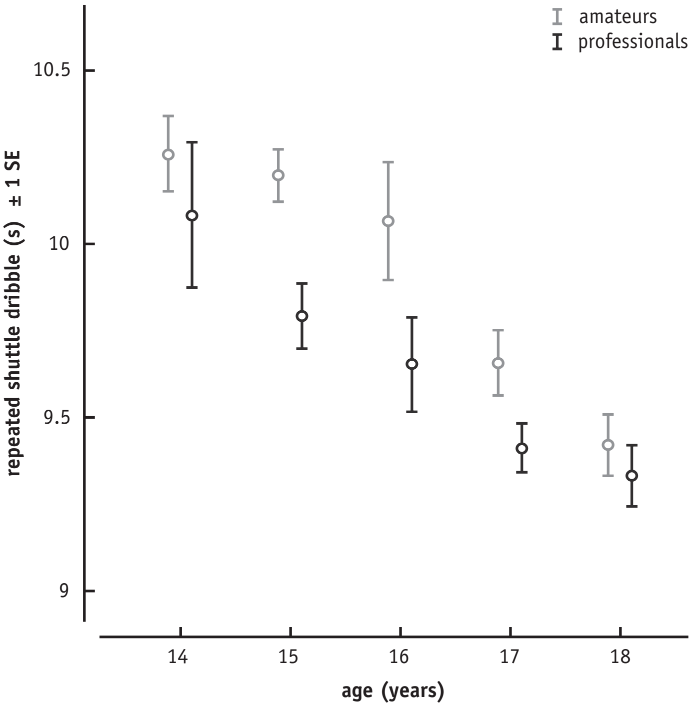

Figure 4.2 Error bar plots on the development of the peak shuttle dribble in talented soccer players distinguished for current professionals and amateurs

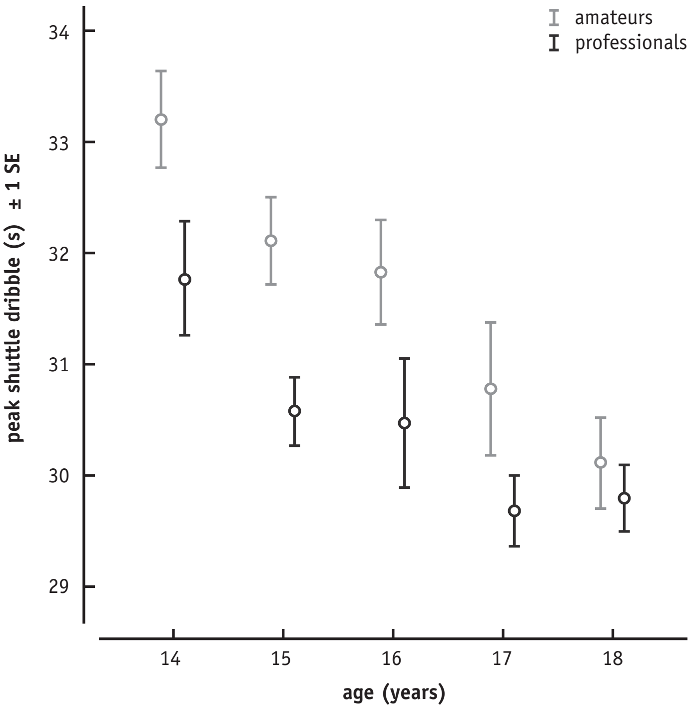

Figure 4.3 Error bar plots on the development of the repeated shuttle dribble in talented soccer players distinguished for current professionals and amateurs

Table 4.5 Multilevel model for the peak shuttle dribble test

Fixed effects	Coefficient	95% CI	Standard error	*P*
Intercept (constant)	10.05	9.83 – 10.28	0.11	<0.001
Professional	0	0	0	
Amateur	0.26	0.11 – 0.41	0.07	0.001
Age 14	0	0	0	
Age 15	−0.17	−0.42 – 0.08	0.12	0.177
Age 16	−0.31	−0.56 – −0.05	0.13	0.018
Age 17	−0.66	−0.91 – −0.41	0.13	<0.001
Age 18	−0.80	−1.05 – −0.55	0.13	<0.001
Random effects	**Variance**		**Standard error**	
Residual intercept (level 1)	0.26		0.03	
Intercept between players (level 2)	0.03		0.02	
Deviance	375.8			
Deviance empty model	452.5			
$p < 0.05$				

The model for peak shuttle dribble shows that all players (current professionals as well as amateurs) are estimated to improve the most (0.35 seconds) from age 16 to age 17 ($p = 0.001$). The model for repeated shuttle dribble shows that all players are estimated to improve most from age 14 to age 15 (1.39 seconds) and from age 16 to age 17 (1.03 seconds) ($p = 0.003$ and $p = 0.008$ respectively).

Table 4.6 Multilevel model for the repeated shuttle dribble test

Fixed effects	Coefficient	95% CI	Standard error	*P*
Intercept (constant)	32.27	31.39 – 33.14	0.44	<0.001
Professional	0	0	0	
Amateur	1.07	0.44 – 1.69	0.31	0.001
Age 14	0	0	0	
Age 15	−1.39	−2.31 – −0.48	0.46	0.003
Age 16	−1.62	−2.57 – −0.67	0.48	0.001
Age 17	−2.65	−3.59 – −1.71	0.48	<0.001
Age 18	−2.77	−3.71 – −1.83	0.48	<0.001
Random effects	**Variance**		**Standard error**	
Residual intercept (level 1)	3.26		0.45	
Intercept between players (level 2)	1.16		0.47	
Deviance	1019.7			
Deviance empty model	1074.1			
$p < 0.05$				

Discussion

The goal of this study was to investigate the relationship between the development of the technical skill dribbling during ages 14 to 18 and adulthood playing level. Earlier research has not yet acknowledged the necessary level of technical skills needed during adolescence to reach the highest level in soccer later on in their career. The current research monitored the dribbling performances of highly talented soccer players during adolescence. The players were followed until adulthood to find out which playing level the talents ultimately reach (professional versus amateur). It is found that players who ultimately reached professional level in soccer outscored players who reached amateur status on dribbling during adolescence.

The differences in dribbling performance between talented soccer players who ultimately reached professional status and their talented counterparts who reached amateur status were significant different from ages 14 to 18. The estimated dribbling performance showed that the players who ultimately reached professional status were on average approximately 0.3 seconds faster than the players who turned amateur later on in their career. This time difference is essential in match play in winning possession of the ball, dribbling around an opponent, or scoring a goal (Bangsbo, 1994; Reilly et al., 2000; Rienzi et al., 2000). The model showed the largest improvement on peak dribble performance from age 16 to age 17 ($p < 0.05$).

The players who ultimately reached professional status also outscored the players who not reached the highest playing level during adulthood on their repeated shuttle dribbling performance. These performance differences were also significant from ages 14 to 18. The estimated model showed that the players who ultimately reached professional status, were on average more than one second faster than the players who turned amateur. This indicates that the players who turned professional were able to recover rapidly (Balsom, Seger, Sjodin, & Ekblom, 1992; Bangsbo, 1994) and showed an enhanced performance for dribbling under fatigue compared to players who turned amateur. The model showed the largest improvements in repeated dribbling performance from age 14 to age 15 and from age 16 to age 17 ($p < 0.05$). These results of the improvement from age 14 to age 15 are in line with previous research including dribble tests covering short distances with quick turns over 180°. Kukolj, Ugarkovic, & Jaric (2003) tested the national Yugoslav youth selections (age 13 to age 18), being very talented players. The observed age associated differences in their study were most prominent from age 13-15 on the dribble test. This suggests that the performance improvements over ages are the largest in early adolescence.

The ultimately successful players' characteristics showed remarkable differences compared to the talented group who was ultimately less successful. The players who became professional during adulthood, appeared to be advanced in physical characteristics during adolescence; they were taller and heavier than their talented counterparts, especially during their younger years (ages 14-16). A reason might be that these players were advanced in maturation. Unfortunately, maturity status was not considered during time of testing the youth soccer players. However, previous research indicated that early maturing boys may be taller than average or late maturing boys during all stages of adolescence (ages 13-18) (Roemmich & Rogol, 1995). Therefore, assumptions can be made that the current professional soccer players were early matures. The study was set up with a longitudinal design and therefore the boys who continued the developmental program were tested more than once. Earlier research stated that maturation does not occur at the same chronological age for all talented soccer players (Malina et al., 2005). Therefore, talented young soccer players with the same chronological age, might present considerable differences in the developmental acquisition of physical characteristics (Jones, Hitchen, & Stratton, 2000). Malina et al. (2005) indicated that advanced biological maturity status is associated with slightly better technical performance (Malina et al., 2005). The second characteristic that differed between the two groups during adolescence is hours of practice. The current professional players appeared to spend more hours in soccer practice per week than their talented counterparts who became amateurs. This is in line with earlier research, it is indicated that practice is a major feature for the development of soccer skills (Ericsson, Krampe, & Teschromer, 1993; Helsen, Hodges, Van Winckel, & Starkes, 2000; Helsen, Starkes, & Hodges, 1998) and therefore important to reach ultimate success in soccer. Finally, it is remarkable that the ultimate successful players participated in more testing sessions, 39% of these players fulfilled 3 or more measurements, in contrast only 12% of the ultimate less successful players fulfilled 3 or more measurements. This indicates that the ultimate professional players started the developmental program at an earlier age and stayed longer in the program than their talented counterparts. For that reason receiving specialized coaching and training over a prolonged period of time is once again demonstrated to be important to ultimately reach the highest level (Vaeyens et al., 2006).

The multilevel analyses showed no significant interaction between age and adulthood playing level on the dribble tests. This indicates that the difference in dribbling performances between professionals and amateurs during adolescence do not significantly differ over the ages. Although, the interaction effect did not significant improve the model, this interaction effect might be relevant. The descriptive statistics showed that the performance differences between current professionals and current amateurs tend to be larger during early adolescence (age 14 to 16) than during late adolescence (age 17 to 18). A reason for the more visible performance differences during especially age 15 might be the advanced physical characteristics of the current professionals compared to the current amateurs. The advanced physical characteristics may result in increased physical skills and therefore better developed dribbling performance on the Shuttle Dribble Test (Malina et al, 2005). A presumption for the tendency of the smaller performance difference and large overlap in performance at the age of 18 on dribbling might be the ceiling effect of dribbling performance. As an player's level of performance improves towards the ceiling, it becomes more difficult to improve. This may suggest that the development of dribbling performance in professionals is quicker than in amateurs. Another reason for the large overlap in performance differences around age 18 for professionals and amateurs, might be that too much energy is demanded for adolescents who only reach amateur status, to improve technical skills (i.e. dribbling). Therefore other skills (tactical, physiological, psychological, etc.) may not develop sufficiently to reach the top. Although technical skills play an important role in professional soccer, it is only one of the multidimensional performance characteristics that accounts for on-field performance. To reach professional level in soccer, at least four multidimensional qualities are needed, i.e. physiological, technical, tactical, and psychological (Cometti et al., 2001; Ericsson et al., 1993; Lemmink et al., 2004; Reilly et al., 2000; Rienzi et al., 2000). Therefore, future research should also investigate the other multidimensional performance characteristics in soccer (Elferink- Gemser, Visscher, Lemmink, & Mulder, 2007; Morris, 2000; Reilly et al., 2000; Rienzi et al., 2000; Williams & Reilly, 2000).

A shortcoming of the current study was the average low numbers of measurements per player, on average 1.8 measurements per player were taken. Reasons for the low number are drop-out of the developmental program because of poor performance, injuries of the players, or absence (by accident) during time of testing. The drop-outs due to poor performance could give bias to the results. For the professionals this problem did not occur and the proportion of amateurs who dropped out due to bad performance was rather low (< 15%). Therefore its impact is assumed to be only small. Nevertheless, especially players who reached amateur status during adulthood had a greater probability of dropping out due to poor performance than players who reached professional status. However, it could be assumed that the performance of these players who dropped out is poorer than the players who did not drop-out, and therefore the performance of amateurs in our models will be overestimated instead of underestimated supporting our conclusions. Therefore, we expect that the current data give a satisfactory illustration of the differences in development of talented young soccer players who ultimately reach professional status and talented players who reach amateur status. Neglecting this bias (in the right direction), the models of dribbling development could also be used as prediction models. The models created in this study can be tested with talented players, who should be tested annually to indicate if having superior skills on the ShuttleDT is indeed a good predictor for future performance level. Soccer skill requirements are changing over the years, therefore the soccer players' performances need to improve constantly (Vaeyens et al., 2006). Consequently, the created models should be adjusted when soccer is played at a 'higher' tempo.

It can be concluded that dribbling performance during adolescence can assist in hypothesizing the successful players for the future. The current longitudinal study showed that dribbling performance between talented players who are ultimately successful versus less successful later on in their career is hypothesized to differ from age 14 to age 18, in favor of the talents who turn professional. The talents who turn professional, are also hypothesized to outscore the amateurs from age 14 to age 18 on the repeated dribbling performance (dribbling under fatigue). Therefore, the required level of dribbling performance and dribbling development necessary during adolescence to reach the top in professional soccer can be derived from the estimated performance models.

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Chapter 5

Multidimensional performance characteristics in selected and de-selected talented soccer players

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Abstract

The present study examined whether performance characteristics discriminated between selected and de-selected players in talent development programs. This examination was carried out in talented soccer players, ages 16-18 using objective measurement instruments. Four domains of multidimensional performance characteristics (physiological, technical, tactical and psychological) were assessed by using a test battery consisting of soccer-specific field tests and questionnaires. Multivariate analyses of covariance revealed that the physiological characteristics peak and repeated shuttle sprint, the technical characteristics of peak and repeated shuttle dribble, and the tactical characteristic of 'positioning and deciding', significantly differed between the selected (n = 76) and de-selected players (n = 37) with selected players performing better ($p < 0.05$). Discriminant function analysis showed that the combination of the technical characteristic 'peak dribbling', the tactical characteristic 'positioning and deciding' and the physiological characteristic of 'peak sprinting' classified 69% of talented players correctly. In conclusion, the decisions made by the investigated clubs to either select or de-select players in their talent development program, whom were aged 16 to 18, were mostly discriminated by aspects of the players' technical, tactical, and physiological skill performances. Sports research can play an essential role in investigating the club's perception of important performance characteristics in talented players.

Key words: technical skill, tactical skill, physiological skill, elite, talent development

Introduction

Talent development programs of Dutch professional soccer clubs aim to educate young players towards professional soccer in adulthood. Soccer scouts observe youth players during local competitions, and consequently the clubs give who they believe are the most talented players a chance to enroll in the development program. A talented player is defined as a player who performs better than their peers during training and competition, and who has the potential to become a professional player (Helsen, Hodges, Van Winckel, & Starkes, 2000; Howe, Davidson, & Sloboda, 1998). In the Netherlands, the players who are assumed to be talented are usually part of the development programs, which include players as young as the age of twelve. However, as these young players progress through the development program, some players are allowed to continue training while others are forced to leave. With respect to the latter, such players may be asked to leave due to insufficient performance (compared to their peers) or because they are anticipated to be unable to reach the top level of professional soccer. Earlier research indicated that approximately 50% of the players who were, at the ages 16 -18, still enrolled in a development program in the Netherlands reached the professional level (Kannekens, Elferink-Gemser, & Visscher, 2010).

At the end of each season the trainers, coaches and technical staff decide if a player is allowed to continue in the talent development program.. The opportunity a player has of reaching the professional level is greatly reduced if a player is de-selected, indicating the importance of such a decision. However, despite the importance of these types of decisions, little is known about the criteria upon which they are based.

Predicting long-term success of young soccer players is difficult because a combination of multidimensional characteristics are required in order to become a professional soccer player (Carling, Le Gall, Reilly, & Williams, 2009; Elferink-Gemser, Visscher, Lemmink, & Mulder, 2004a; Reilly, Williams, Nevill, & Franks, 2000b). For instance, soccer is a high-intensity, intermittent game in which both the aerobic and anaerobic energy systems play an important role (Hoff, 2005; Mohr, Krustrup, & Bangsbo, 2005). Technical characteristics, such as dribbling the ball, are also critical to performance, especially during the important moments of a match (Bangsbo, 1994; Reilly, Bangsbo, & Franks, 2000a; Rienzi, Drust, Reilly, Carter, & Martin, 2000; Reilly, 2001). Earlier research has acknowledged dribbling as a skill test that discriminates between youth soccer players of different performance levels (Reilly et al., 2000b). Despite this, it has been demonstrated that in high-level soccer, well developed physiological and technical skills are not sufficient if the timing of the performed actions are not correct (Elferink-Gemser et al., 2004a). Psychological characteristics have also been identified as important for success in soccer (Morris, 2000).

In order to ultimately reach the professional level in team sports, and in particular soccer, it seems that players need to be skillful in each of these four domains of performance; demonstrating well-developed physiological, technical, tactical and psychological characteristics (Elferink-Gemser et al., 2004a; Reilly et al., 2000b). However, it is unknown whether the decisions of the development programs to either select or de-select players are based on any one of these specific multidimensional characteristics or a combination of several.

Research across a group of players who are all considered to be talented can explain a great deal about the possible performance related differences between the players who succeed and those who do not. Underlying mechanisms explaining differences within a talent group are of major importance for those interested in talent identification and talent development. Much of the earlier work in youth soccer that investigated multidimensional characteristics did not focus on possible differences within a talent group, but mainly discriminated between elite, non-elite and recreational players (players of different competitive levels) (Gissis et al, 2006; Reilly et al., 2000b; Vaeyens et al., 2006). Another study has found that differences in physiological, technical and psychological characteristics in youth soccer players (ages 11- 15) differed between the players that dropped out, continued at the club level or were selected by elite clubs (Figueiredo, Goncalves, Coelho E Silva, & Malina, 2009). Consequently, these studies employed groups that were already highly differentiated in skill level. Recently, some research has been conducted across a group of all talented soccer players (Coelho E Silva et al., 2010; Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007; Gravina et al., 2008; Le Gall, Carling, Williams, & Reilly, 2010; Savelsbergh, Haans, Kooijman, & van Kampen, 2010). However, most of these studies only focused on one or two of the aforementioned domains of the multidimensional performance characteristics.

Hardly any objective information exists on the selection criteria upon which trainers, coaches and staff base their decisions to allow certain players to continue in (selected players) or force to leave (de-selected players) the talent development program. Therefore, the current study investigated whether certain physiological, technical, tactical and/or psychological performance characteristics discriminated between the selected and de-selected players. The aim of this study was to objectively illustrate these selection criteria in young soccer players attempting to obtain connections with the top level of professional soccer.

Methods

Participants

A total of 113 talented adolescent soccer players attending one of two talent development programs of professional soccer clubs in the Netherlands participated in this study. The Netherlands has a total of 13 talent development programs of professional soccer clubs. Their aim is to develop talented players into a professional career under optimal circumstances. In the development programs, players are included from age 12 until age 18. Development programs may well be described as containing two phases. The players tested in the current study were all part of the second and last phase of the development program, these players are at the stage after peak height velocity and attempting to obtain connection with professional soccer. It is considered as a rather homogeneous group.

All of the players in the current study had been enrolled in their respective development program for at least two consecutive years (club 1: 50 players, club 2: 63 players). At the end of the season, 76 of the players were allowed to continue in the development program (selected players), while 37 of the players were forced to leave (de-selected players). The de-selection rate for club 1 was 38% and for club 2 was 29%. The distribution of the age of these players was as follows: age 16, 19 selected and 8 de-selected; age 17, 35 selected and 17 de-selected; and age 18, 22 selected and 12 de-selected. All players were considered talented by scouts, trainers and staff of the respective clubs. The level of competition within the Dutch professional soccer clubs and their development programs are among the highest in the world. The players competed at the highest national level and belonged to the best 0.5% of the total number of soccer players in their age group (KNVB, 2009). All players were assessed in the physiological, technical, tactical and psychological domains while being part of the talent development programs.

In Table 5.1, the age, birth semester, anthropometrics, soccer history, and training characteristics are presented. Soccer practice was defined as the average number of hours of practice spent per week at the talent development program during the competitive season in which the player is measured. Additional practice was described as the average number of hours of sports activities spent outside of the talent development program during the competitive season. The duration of the competitive season was approximately 40 weeks. T-tests were performed to reveal possible differences between the selected and de-selected players with respect to the descriptive variables. A significant difference was found between the ages of the players entering the development program, with the selected players entering the program at a younger age than the de-selected players ($p < 0.05$, $d = 0.45$). No other significant differences were found between the groups ($p > 0.05$).

Table 5.1 Descriptives (mean + SD) of talented soccer players (*N*=113) classified by selected and de-selected players of the talent development program on age, birth semester, anthropometrics, and practice hours

	Selected	n	De-selected	n	*p*
Age	17.04 + 0.69	76	17.21 + 0.73	37	0.23
Players born in 1st semester	60.5%	46	73.0%	27	0.03
Players born in 2nd semester	39.5%	0	27.0%	10	<0.01
Height (m)	1.77 + 0.07	73	1.78 + 0.07	36	0.69
Weight (kg)	70.44 + 7.79	73	69.88 + 6.77	36	0.71
Body fat %	8.29 + 2.68	73	8.05 + 2.93	35	0.67
Lean body mass (kg)	64.62 + 7.55	73	64.02 + 6.29	35	0.68
Age starting soccer	6.45 + 1.64	73	6.26 + 1.69	36	0.59
Age entering development program	13.78 + 1.83	73	14.58 + 1.75	33	0.04
Soccer practice/week (hrs)	8.77 + 1.79	74	8.41 + 1.43	37	0.29
Additional practice/week (hrs)	2.24 + 2.64	74	2.51 + 3.47	37	0.62

Note: *n* varies per characteristic, because of at random missing data on anthropometrics and/or training characteristics or training history

Physiological characteristics

Four physiological characteristics were measured using three field tests. These characteristics included peak shuttle sprint performance, repeated shuttle sprint performance, slalom sprint performance and interval endurance capacity. The peak shuttle sprint and repeated shuttle sprint performances were measured using the Shuttle Sprint and Dribble Test (ShuttleSDT) (Lemmink, Elferink-Gemser, & Visscher, 2004a). This soccer-specific test consisted of three maximal sprints of 30 m each. The players were allowed a short rest between successive 30 m sprints. The start of the next sprint started exactly 20 s after the start of the previous one. Each 30 m sprint consisted of three 180˚ turns, which required the players to cross a line with both feet prior heading in the opposite direction. Timing data were measured by means of photoelectric cell gates (TAG Heuer, Eraton BV Digital Timing Equipment, Weert, The Netherlands). The peak shuttle sprint performance was taken as the time covered in the fastest of the three 30 m sprints, while the repeated sprint performance was taken as the total time required in completing all three 30 m sprints. In the current study, the first sprint was almost always the fastest (in only 9 occasions (≈ 8%) this was not the case). The difference between the fastest and the slowest sprint was on average 0.28 s (SD = 0.28), $p < 0.001$. This difference is beyond trial-to-trial error variation, the reliability study (Lemmink et al., 2004a) indicated a maximum trial-to-trial error variation of 0.03 s. The reliability of the ShuttleSDT was assessed during pilot testing in youth soccer players. The results showed good relative as well as absolute test-retest reliability (Huijgen, Elferink-Gemser, Post, & Visscher, 2009).

Slalom sprint performance was measured by using the Slalom Sprint and Dribble Test (SlalomSDT) (Lemmink et al., 2004a). This protocol consisted of a maximal slalom sprint, whereby twelve cones were placed in a zigzag pattern and the subject had to slalom the 30-m course as fast as possible. The reliability and validity of the SlalomSDT for intermittent sport players had been confirmed (Lemmink et al., 2004a).

Intermittent endurance capacity was measured with the Interval Shuttle Run Test (ISRT) (Lemmink, Visscher, Lambert, & Lamberts, 2004b). During the ISRT, players are required to run back and forth on a 20-m course with pylons set 3 m before the turning lines. The frequency of the sound signals on a pre-recorded compact disc increased in such a way that running speed was increased by 1 km/h every 90 seconds from a starting point of 10 km/h and by 0.5 km/h every 90 seconds from 13 km/h onwards. Each 90-second period was divided into two 45-second periods in which players ran for 30 seconds and walked for 15 seconds (work to rest ratio 2:1). Subjects were instructed and encouraged to complete as many 20-m runs as possible. The test stopped when the subjects could not follow the pace (i.e., more than 3 m before the 20-m lines at 2 consecutive audio signals) or felt unable to complete the run. This was the number reported as the test score. The reliability and validity of the ISRT for intermittent sport players has been confirmed (Lemmink et al., 2004b).

Table 5.2 Correlations between and within physiological and technical characteristics

	Slalom sprint	Slalom dribble	Peak shuttle sprint	Repeated shuttle sprint	Peak shuttle dribble dribble	Repeated shuttle dribble
Slalom sprint	1,000	,212*	,218*	,208*	,255**	,292**
Slalom dribble		1,000	-,058	-,056	,257**	,208*
Peak shuttle sprint			1,000	,868**	,335**	,314**
Repeated shuttle sprint				1,000	,339**	,304**
Peak shuttle dribble					1,000	,763**
Repeated shuttle dribble						1,000

* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level

Technical characteristics
The three technical characteristics of peak shuttle dribble, repeated shuttle dribble and slalom dribble performance were measured by the ShuttleSDT and SlalomSDT. Players now were required to perform the tests while dribbling the ball. If the player lost control over the ball, that is, if the player was more than approximately 2 m away from the cones, the test was repeated. The absolute and relative reliability of the ShuttleSDT for youth soccer players has been confirmed (Huijgen et al., 2009; Huijgen, Elferink-Gemser, Post, & Visscher, 2010). The reliability and validity of the slalom dribble for intermittent sports has been confirmed (Lemmink et al., 2004a). The correlations between the different physiological and technical characteristics and correlations within these characteristics (i.e., peak and repeated sprint/dribble) of the current group of soccer players are illustrated in Table 5.2. In the current study, the first dribble was 25 times not the fastest (≈ 21%). The difference between the fastest and slowest dribble was on average 0.32 s (SD = 0.74) $p < 0.001$. This is beyond trial-to trial error exceeding at least twice the trial-to trial error variation in the reliability study (Lemmink et al., 2004a).

Tactical characteristics
The tactical skills of 'Knowing about ball actions', 'Knowing about others', 'Positioning and deciding', and 'Acting in changing situations' were measured with the Tactical Skills Inventory for Sport (TACSIS) (Elferink-Gemser, Visscher, Richart, & Lemmink, 2004b). The TACSIS consisted of twenty-two items that required the players to compare their sport performance with that of the top players in their age category. The players responded to each item on a 6-point Likert scale (1 = "very poor" or "almost never" and 6 = "excellent" or "always"). In previous research, the TACSIS was shown to have good psychometric characteristics (Elferink-Gemser et al., 2004b).

Psychological characteristics
Two types of dispositional goal orientations (i.e., task and ego goal orientation) were assessed using the Task and Ego Orientation in Sport Questionnaire (TEOSQ; Duda, 1989). In the TEOSQ, players were asked to indicate on a 5-point Likert scale (1 = "strongly disagree" and 5 = "strongly agree") to what extent they agreed with each of the 13 items. Be-

cause of the nationality of the participants, the players filled out the Dutch translation of the TEOSQ. Internal consistency coefficients of the Dutch translation of the TEOSQ ranged from 0.84 to 0.88 for task orientation and were repeatedly 0.82 for ego orientation (Van-Yperen & Duda, 1999). Players also completed the Dutch Youth Version of the Psychological Skills Inventory for Sports (PSIS-Youth; Elferink-Gemser, Visscher, & Lemmink, 2008), which was based on the Psychological Skills Inventory for Sports (PSIS-R-5; Mahony, Gabriel, & Perkins, 1987). Scores were measured using a 5-point Likert scale (1 = "almost never", 5 = "almost always"). The PSIS was developed to directly assess an athlete's psychological skill relevant to athletic training and exceptional performance. It assesses level of motivation, self-confidence, anxiety control, mental preparation, team emphasis and concentration. The questionnaire contained 44 five-point Likert-type questions. A high score on the scale corresponded to the psychological skill being present to a large extent. The maximum mean score on each scale was 5 and the minimum was 1. In previous research, the PSIS was shown to have sufficient psychometric characteristics (Mahony et al., 1987). Internal consistency estimates for each scale were acceptably high, ranging from .68 on the Team Emphasis scale to .81 on the Confidence scale (Elferink-Gemser et al., 2008).

Procedures

All players were informed about the procedures of the study before providing their consent to participate. Permission was received from the professional clubs and their respective trainers prior to completing the study. The procedures were in accordance with the ethical standards of the Medical Faculty of the University of Groningen. All measurements were taken during the competitive season, well in advance of when the decisions were made about the player's future in the program. The trainers, coaches and staff did not receive the test results before or while these decisions were being made. The physiological and technical tests were completed on an artificial grass soccer field. The players were told that the test results would remain anonymous to the trainers and staff and thus, were asked to complete the questionnaire in an honest manner to ensure maximum accuracy and validity of the results.

Data analysis

SPSS version 16.0 (SPSS, 2005) was used for the statistical analyses. Mean scores and standard deviations were calculated for each variable according to the four domains of performance characteristics (physiological, technical, tactical and psychological) for both groups (selected versus de-selected players). A multivariate analysis of covariance (MANCOVA's) was performed to compare the selected and de-selected players in all of the performance characteristics. Chronological age was used as a covariate in all analyses to control for the influence of physical development on the performance characteristics. In conducting the MANCOVA, group (selected versus de-selected players) was the between-participant variable and the measurements of the performance characteristic domains were the dependent variables. Follow-up analyses were undertaken using post-hoc Bonferroni-corrected pairwise comparisons where appropriate. Cohen's effect sizes (*d*) were used for interpretation of small (0.20), medium (0.50) and large (0.80) effects (Cohen, 1988). Finally, all performance characteristics were analyzed together using a stepwise discriminant function analysis to determine which combination of the measured characteristics optimally explained the decision for a player to continue or be forced to leave the program. In this analysis, group (selected versus de-selected players) was the dependent variable and the performance characteristics and age were the independent variables. An alpha of 0.05 was adopted for all tests of significance.

Results

Table 5.3 illustrates the mean scores of the four multidimensional characteristics for both groups. The results of the MANCOVA revealed a significant main effect for group ($F19, 92 = 1.94$; $p = 0.020$, partial Eta squared 0.29). Follow-up analyses revealed a significant difference between the selected and de-selected players on the physiological characteristics peak shuttle sprint ($p = 0.001$; $d = 0.57$) and repeated shuttle sprint ($p = 0.017$; $d = 0.47$); on the technical characteristics peak shuttle dribble ($p < 0.001$; $d = 0.6$) and repeated shuttle dribble ($p = 0.002$; $d = 0.60$); and on the tactical characteristic 'Positioning and deciding' ($p = 0.002$, $d = 0.63$). In all comparisons, the selected players outscored the de-selected players.

Table 5.3 Physiological, technical, tactical and psychological characteristics (mean + SD) of talented soccer players (n = 113) classified by selected and de-selected players and the effect sizes between the two groups

	Selected n = 76	**De-selected** n = 37	**Effect size** (*d*)
Physiological characteristics			
Slalom Sprint (s)	13.60 + 0.61	13.87 + 0.73	0.40
Peak Shuttle Sprint (s)	7.95 + 0.27*	8.09 + 0.22*	0.57*
Repeated Shuttle Sprint (s)	24.46 + 0.73*	24.80 + 0.73*	0.47*
ISRT (runs)	105.92 + 21.38	104.35 + 24.84	0.07
Technical characteristics			
Slalom Dribble (s)	20.48 + 1.47	21.03 + 1.53	0.37
Peak Shuttle Dribble (s)	9.38 + 0.32*	9.61 + 0.35*	0.66*
Repeated Shuttle Dribble (s)	29.30 + 1.35*	30.17 + 1.53*	0.60*
Tactical characteristics			
Knowing about ball actions	4.32 + 0.66	4.15 + 0.65	0.26
Knowing about others	3.92 + 0.62	3.84 + 0.56	0.14
Positioning and deciding	3.90 + 0.52*	3.58 + 0.49*	0.63*
Acting in changing situations	3.99 + 0.72	4.25 + 0.71	0.36
Psychological characteristics			
Task orientation	3.80 + 0.68	3.66 + 0.70	0.20
Ego orientation	3.53 + 0.79	3.49 + 0.82	0.05
Motivation	3.77 + 1.29	3.89 + 1.24	0.09
Self-confidence	3.60 + 0.76	3.36 + 0.66	0.34
Anxiety control	3.79 + 1.06	3.47 + 1.07	0.30
Mental preparation	2.86 + 0.87	2.72 + 0.82	0.17
Team emphasis	3.10 + 0.60	3.03 + 0.59	0.12
Concentration	3.52 + 0.76	3.21 + 0.80	0.40

Note: * $p < 0.05$

Table 5.4 Stepwise discriminant analysis; variables entered

			Exact *F*			
Step	**Entered**	**Lambda**	**Statistic**	**df1**	**df2**	***p*-value**
1	Technical skill Peak shuttle dribble	0.90	11.80	1	111	< 0.01
2	Tactical skill Positioning and deciding	0.85	9.99	2	110	< 0.01
3	Physiological skill Peak shuttle sprint	0.81	8.29	3	109	< 0.01

Note: at each step, the variables that minimizes the overall Wilks' lambda is entered. Minimum partial *F* to enter is 3.84, maximum partial *F* to remove is 2.71

The stepwise discriminant analysis' results are illustrated in Table 5.4. The model demonstrated that a combination of three characteristics optimally discriminated between the selected and de-selected players. These characteristics, in order of importance, were the technical skill of peak shuttle dribble performance (–.683), the tactical skill of 'Positioning and deciding' (.632), and the physiological skill of peak shuttle sprint performance (–.553). The peak shuttle sprint and dribble performances received negative values, meaning that a lower score represented a better performance (i.e., less time needed for the test). The tactical skill 'Positioning and deciding' received a positive sign, meaning that a higher score represented better performance. These three variables correctly classified 69.0% of the players as either being allowed to continue in the development program or forced to leave.

Discussion

The present study examined whether multidimensional performance characteristics discriminated between the selected and de-selected players in a talent development program, using objective measurement instruments. Differences between selected and de-selected players were found on the Shuttle Sprint and Dribble Test (the physiological characteristics peak and repeated sprinting, and the technical characteristics peak and repeated dribbling), and on the tactical characteristic of 'Positioning and deciding'. The discriminant analysis in the current study revealed that peak dribbling, 'Positioning and deciding' and peak sprinting accounted for almost 70% of the correct classification of the talented players. The respective group differences in the repeated sprint and dribbling tests are mostly accounted for by the group differences in the skills measured in the peak sprint and dribble and, most probably, are therefore not included in the discriminant analysis. In a similar study that used identical multidimensional performance characteristics to examine talented field hockey players, dribbling, 'Positioning and deciding', motivation and slalom dribble performance distinguished the elite from sub-elite players (Elferink-Gemser et al., 2004b).

The players who performed well on the shuttle sprint and dribble test, and on the tactical skill 'Positioning and deciding' were more often allowed to continue in the talent development program compared to those who performed relatively poor. The shuttle dribble test is a measure of the ability of players to accelerate over short distances and quickly change direction (180 degrees) while dribbling the ball. Previous studies have shown that dribbling the ball is a technical skill that is able to discriminate between players of different competitive levels (e.g., Figueiredo et al., 2009; Reilly et al., 2000b). Earlier research with players in development programs demonstrated that, during adolescence (age 14-18), the players who ultimately reached the professional level of soccer received higher scores on the shuttle dribble performance compared to those who only reached the amateur level (Huijgen et al., 2009). In a group of talented youth handball players, motor, physical and skill characteristics were tested. This study found only that performance on a dribbling test differed between the players that were selected for the National team and those that were not (Lidor et al., 2005). 'Positioning and deciding' refers to the ability to make quick decisions and being in the right place at the right moment ('doing it') (e.g., McPherson, 1994; Thomas & Thomas, 1994). No differences in declarative knowledge ('Knowing what to do') were found within this group of all highly skilled players, since the selected as well as the de-selected players scored on average comparable high scores. However, general differences exist between knowing what to do and actually carrying out these actions during a game (Elferink-Gemser, Kannekens, Lyons, Tromp, & Visscher, 2010; Kannekens, Elferink-Gemser, & Visscher, 2010).

Differences between the selected and de-selected players on the physiological characteristic sprinting, were unlikely to be influenced by the growth and maturation of the players of different ages, as non-significant differences in anthropometrics were found. In addition, the age range of the players (16-18 years) suggested no important role for growth and maturity status. It has only been noticed that in younger soccer players, variation in maturity status and body size between the players of different ages was found to significantly contribute to variation in the performance of the physiological and technical skills (13-15 years) (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004; Malina et al., 2005). Earlier studies conducted within groups of all talented soccer players also found significant differences between performance levels on the physiological characteristics sprint and agility (Coelho E Silva et al., 2010; Figueiredo et al., 2009; Gil et al., 2007; Gravina et al., 2008; Le Gall et al., 2010; Vaeyens et al., 2006).

The majority of the talented players in this study received high scores on the psychological skills, with the average scores surpassing 3.5 on a 5-point Likert scale. However, non-significant differences were found between selected and de-selected players. Earlier research, however, has recognized that psychological factors often distinguish between the most successful and successful talented players (Morris, 2000; Hanton, Neil, Mellalieu, & Fletcher, 2008).

Although the correct classification rate of the discriminant analysis in the current study was fairly high, other factors influence the club's decision to either keep a player or ask them to leave the program. This includes for example the players' suitability for the short-term success of the team, decision of the player himself, performance during games, the number of available places on the team and the type of relationship developed between the player and coach. Other possible factors that are recommended to be included in future studies include position specific requirements (e.g., Di Salvo et al., 2007; Gil et al., 2007; Taskin, 2008), the social value that a player adds to the team and excellence in a specific domain. In addition, not all aspects of the multidimensional performance characteristics are measured, for instance, technical skills in soccer, do not only exist of dribbling, but also passing, ball control, shooting, etc. The included measurement instruments can also be discussed. For instance, the tactical and psychological skills are measured with a questionnaire. Such a self-reported measure is susceptible to the respondent's self-confidence (Mahony et al., 1987). Others have chosen a more objective methodology, e.g., visual search behaviors and decision making in lab based experiments (e.g., Savelsbergh et al., 2010; Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007; Williams & Davids, 1998; Williams, Davids, Burwitz, & Williams, 1994). However, these methods lack 'real-world' stimuli such as the pressure of opponents, time constraints and stress to which players in games need to respond and act (McPherson, 1994)

To enhance our knowledge about the process of talent selection and development, future research can expand upon the current study. For instance, selection criteria are most likely not universal across all age groups. Furthermore, information can be obtained regarding the possibility of different selection procedures used for players in different age ranges. In order to do this, the selection process in younger players could be objectified using the same method as in the current study, while taking into account several other factors such as maturation and training history.

Furthermore, studying the performance characteristics of individual players instead of groups might show effects called the 'compensation phenomenon', which suggests that shortcomings in one performance characteristic may be compensated by excellence in another (Bartmus, Neumann, & Demarees, 1987). This may lead to the consideration of a minimum criterion level being adopted for each performance characteristic (Vaeyens et al., 2008). This is based on the assumption that it is not the individual performance characteristics that determine the performance level of a player, but is instead the combination of such characteristics. One way to do this is to apply tests that require players to select and perform the correct technique as determined by the demands of the situation (Ali et al., 2007), distinguishing between a speed and accuracy component. In addition, novel measurement devices that can objectively measure the players' 'total' performance, including physiological, technical and tactical skills, during for instance actual competition should be developed (Vaeyens et al., 2008). Instead of studying age groups in a cross-sectional manner, future studies could also assess players as a group as they progresses through the stages of the development program, by means of a longitudinal design.

The purpose of the current study was to examine the selection criteria upon which two Dutch professional soccer clubs' based their decisions to select or de-select players for continuation in their respective development programs. However, until now, little insight has been placed on examining the underlying principles that govern the selection processes in these development programs. The current study shows that it is possible to gain insight into the selection process by using objective measurement instruments. By recognizing the rationale behind these decisions to either keep or release players from the development program, the clubs may become more aware of the specific performance characteristics that they find important in the development of their young players. This would allow clubs to create a structured development program plan based on these characteristics, which would allow trainers to focus their attention, in this case on certain aspects of technical, tactical, and physiological characteristics.

Therefore, this research could be of great importance to any type of talent development program looking to generate a more definitive picture of the type of performance characteristics they would like to impart into the training and selection of young players.

The clubs decisions regarding continuance in the development program (versus being de-selected) reflects the chances a player has of reaching the professional level. The current results imply that for the two Dutch soccer clubs used in this study, the variables that distinguished between selected and de-selected players, aged 16-18, were primarily certain aspects of the players' technical, tactical and physiological skill performance. Taken in this regard, sports research can potentially play an essential role in investigating the club's perception on important performance characteristics in talented players for different age groups.

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Chapter 6

Soccer skill development in talented players

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Abstract

The aim of the study was to gain insight into the development of soccer-specific skills and whether differences between talented players exist on the Loughborough Soccer Passing Test (LSPT). Two scores were derived from the LSPT: 1) execution time: time to complete 16 passes (speed) and 2) skill performance time: execution time including bonus and penalty time for accuracy. The study consisted of two parts, the first of which incorporated a quasi-longitudinal design with 270 talented players aged 10 to 18 performing the LSPT (661 measurement occasions); multilevel modelling was applied. Secondly, differences between those players allowed to continue in the development program (selected, n = 269) and players who were forced to leave (de-selected, n = 50) were investigated using independent sample t-tests. The longitudinal data showed that the predicted execution time (i.e. speed) improved approximately 18% from age 10 to age 18 ($p < 0.05$), skill performance time (i.e., combination of speed and accuracy) was predicted to improve approximately 32% ($p < 0.05$). The second part showed that selected players outscored de-selected players only on skill performance time ($p < 0.05$), not on execution time ($p > 0.05$). In conclusion, in high-level youth soccer, the combination of speed and accuracy in soccer skills might be more important than speed alone.

Key words: elite, accuracy, speed, longitudinal, technique, passing

Introduction

One of the key objectives of professional soccer clubs is to develop young talented players into successful players for their first team. In soccer, the key stages in the talent identification and development process can be distinguished as 'identification', 'development', and 'selection' (Vaeyens, Lenoir, Williams, & Philippaerts, 2008; Williams & Reilly, 2000). Talent identification denotes the process of recognizing current players with the potential of becoming a professional (Williams & Reilly, 2000). The development programs in the Netherlands aim to identify the most talented young players (from about age 10) who are subsequently offered an excellent training environment in which to hone their skills and reach their full potential, this is known as talent development (Williams & Reilly, 2000). Nevertheless, the prediction of long-term success is extremely complex and only few of the initially selected players ultimately reach the top (Vaeyens et al., 2008). At the end of each competitive season the trainers, coaches and technical staff decide if a player is allowed to continue in the talent development program. This process of talent selection involves identifying players at various stages who demonstrate prerequisite levels of performance for inclusion in a given team (Williams & Reilly, 2000). Once a player is forced to leave the program, and therefore unlikely to receive specialized coaching and training, the chances of becoming a professional soccer player are greatly reduced (Williams & Reilly, 2000). To optimize talent development and talent selection it is necessary to classify important indicators that can assist in predicting success.

Recently, outstanding dribbling performance in young talented soccer players was acknowledged as an important indicator for reaching professional soccer (Huijgen, Elferink-Gemser, Post, & Visscher, 2009). In addition, other soccer skills, such as shooting, passing and ball control are of major importance in the development of youth soccer players (Ali et al., 2007; Meylan, Cronin, Oliver, & Hughes, 2010; Reilly & Holmes, 1983). Skill has been defined as the learned ability to bring about pre-determined results with maximum certainty, often with the minimum outlay of time or energy or both (Knapp, 1963). Therefore, expertise in soccer depends not only on fast execution of technical skills but also on accurate execution of these skills. Earlier studies indicated that elite players make faster and more accurate decisions than novice or sub-elite players (Thomas, French, & Humpries, 1986; Williams, Davids, Burwitz, & Willams, 1993).

At a high performance level many constraints are imposed on players by their opponents. To be in control during the game, players should not only be able to execute their technical skills quickly, but also the precision (accuracy) of the skill performances influences the winning of possession of the ball during games (Russell & Kingsley, 2000). However, numerous studies have demonstrated that the quicker these techniques are performed the greater the increase in errors (Etnyre, 1998; Mackay, 1982; Plamondon & Alimi, 1997) i.e. the so-called speed-accuracy trade-off (Fitts, 1976). Indeed, during soccer, maintenance of kicking accuracy has been shown to reduce the speed of the kick (Anderson & Dorge; Texeira, 1999). Therefore, the quality of the skills is dependent on the interaction between speed and accuracy of execution (Fitts, 1976), information that concerns these subcomponents of technical skills can provide outcome measures that are relevant for the field of talent development and selection (Russell & Kingsley, 2011). In order to be successful during the game, players should select and perform the correct technical skill as determined by the demands of the situation (Ali et al., 2007). A soccer-specific field test that measures the speed and accuracy of technical skills, is the Loughborough Soccer Passing Test (LSPT). In contrast to traditional field tests, in which players know the course and direction of running/dribbling/passing beforehand, the LSPT requires players to react and immediately decide how to execute the task. Therefore the LSPT test assesses the multi-faceted aspects of soccer skill (decision making regarding the execution of skills, dribbling, passing and ball control) within a dynamic context (Ali & Williams, 2009; Ali et al., 2007; Ali, Williams, Nicholas, & Foskett, 2007). Research has shown that this test discriminates between adult players of different competitive levels (Ali et al., 2007). However, it is unknown if this test can also discriminate within a select group of young soccer players.

None of the existing talent development and selection studies (e.g., Burgess & Naughton; Coelho e Silva et al., 2010; Huijgen, Elferink-Gemser, Post, & Visscher, 2010; Meylan et al., 2010; Reilly, Williams, Nevill, & Franks, 2000; Vaeyens et al., 2006) have included tests that investigated the development of the two important components (speed and accuracy) of technical skills in young, talented players. Normative testing data on talented young soccer players can provide insight in the level of the soccer-specific skills necessary to belong to the best national players for every age group. By using a quasi-longitudinal design the key changes in the two components of the soccer-specific skills that occur as a result of increasing age can be determined (Elferink-Gemser, Visscher, Lemmink, & Mulder, 2007; Huijgen et al., 2009; Reilly et al., 2000, Williams & Reilly, 2000). Monitoring the development of talented soccer players over a prolonged period of time can also contribute to an improved understanding and further enhancement of talent development and selection processes.

The overall purpose of the current study was to gain more insight into the development of essential soccer skills that are needed to compete at the highest performance level in youth soccer and examine whether the LSPT is a useful test regarding talent development and selection in young soccer players. Therefore, the first goal is to longitudinally investigate the evolution on LSPT execution and performance time (speed and accuracy) in a group of players, attending development programs of professional soccer clubs, aged 10-18 y. It is hypothesized that the talented soccer players will improve their soccer skills, and therefore their results on the LSPT in the age band from 10-18 y on both executing speed and accuracy. The hypothesis is that LSPT performance would increase most rapidly at a younger age; at an older age, the improvement per year is expected to be less. The second goal is to investigate the differences in LSPT execution and performance time between players who continue in the development program (selected players) versus players who are forced to leave the program (de-selected players). Because of the relative homogeneity of players in talent development programs, the hypothesis is that selected players will only marginally outscore de-selected players.

Methods

Participants

A total of 270 youth soccer players aged 10-18 y, from one of three professional soccer club development programs in the Netherlands, participated in this quasi-longitudinal study. All players who belonged to one of the three development programs were tested. From 2007-2010 measurements were taken twice per year; one at the beginning of the competitive season (October) and the other near the end of the competitive season (February-April). Some players missed testing because of injuries, illnesses, exams, or drop-outs. In our study 71 players conducted four or more measurements, and 199 players had 3 or less measurements, with an average of 2.4 measurements per player. The players competed at the highest national level, in a league that consists of teams that belong to the best 1.0% of the total number of teams in their age group (KNVB, 2009). Overall, the level of Dutch soccer is high with the national team currently (July 2012) ranked eighth in the FIFA world ranking (http://www.fifa.com). Goalkeepers were excluded from the current study. All measurements of the soccer players were analyzed to accomplish the first goal of the study, investigating the evolution on LSPT performance and execution time. The amount of measurements per test occasion per age are shown in Table 6.1, with a total of 661 measurements. As there were overlaps in ages it was possible to estimate a consecutive 9-year development pattern for ages 10-18.

Age groups from U12 (under 12 y group) to U19 were included in the study. At the end of the season (April/May: after the tests were taken) the clubs decide whether a player is allowed to continue in the development program (selected player) or is not allowed to continue the program in the following season (de-selected player). The general characteristics of the selected and de-selected players are presented in Table 6.2. To derive the second goal of the study the measurements near the end of the competitive season were used to compare the selected players (those who moved up to the next age group in the development program) with the de-selected players (players who were forced to leave the program).

Table 6.1 Number of measurements per measurement occasion and age

Age	2007/2008 Occ.1	2007/2008 Occ.2	2008/2009 Occ. 1	2008/2009 Occ. 2	2009/2010 Occ. 1	2009/2010 Occ. 2	Total number of measure-ments
10	0	0	3	0	6	0	9
11	0	0	17	15	34	20	86
12	0	0	20	20	31	39	110
13	0	0	20	19	36	37	112
14	2	1	18	16	26	27	90
15	6	6	12	14	11	19	68
16	8	5	17	11	13	12	66
17	8	4	19	21	12	18	82
18	6	4	7	6	6	9	38
Total	30	20	133	122	175	181	661

Table 6.2 Mean scores (sd) of soccer players in development program on anthropometrics, soccer experience and practice hours, presented by age group

Age group		n	Height (m)	n	Weight (kg)	n	Cum. soccer years	n	Soccer practice/ week (hrs)	n
U12	Selected	53	1.49 (0.08)	52	38.4 (6.1)	52	6.0 (1.2)	31	6.2 (0.5)	53
	De-selected	5	1.48 (0.02)	5	35.4 (0.9)	5	-		6.5 (0.6)	4
U13	Selected	46	1.56 (0.08)	44	42.0 (6.0)	44	6.8 (1.2)	43	6.6 (0.8)	46
	De-selected	6	1.53 (0.08)	6	40.1 (3.7)	6	5.7 (2.5)	3	6.5 (0.5)	6
U14	Selected	44	1.61 (0.10)	43	48.6 (9.0)	43	7.6 (1.4)	42	6.9 (1.2)	44
	De-selected	6	1.60 (0.06)	5	45.4 (3.8)	5	7.3 (1.2)	3	7.4 (1.2)	6
U15	Selected	37	1.68 (0.10)	35	57.1 (9.6)	35	8.9 (1.5)	20	7.4 (1.0)	37
	De-selected	13	1.69 (0.08)	12	60.0 (7.0)	12	8.3 (1.4)	12	6.5 (0.7)	13
U16	Selected	26	1.76 (0.06)	23	64.6 (7.4)	23	9.1 (1.7)	24	8.2 (1.2)	26
	De-selected	3	1.73 (0.08)	3	64.8 (8.8)	3	10.3 (1.2)	3	8.5 (1.7)	3
U17	Selected	31	1.79 (0.06)	28	70.4 (5.9)	28	10.0 (1.8)	27	9.1 (1.3)	30
	De-selected	6	1.76 (0.07)	5	69.6 (3.8)	5	10.6 (0.9)	5	7.8 (0.7)	5
U18	Selected	21	1.79 (0.05)	21	71.9 (5.4)	21	11.0 (1.6)	18	9.2 (0.6)	21
	De-selected	7	1.82 (0.04)	7	78.0 (5.0)	7	10.8 (1.5)	4	9.0 (0.0)	7
U19	Selected	11	1.81 (0.05)	8	74.0 (7.2)	9	12.2 (1.8)	9	9.0 (0.0)	10
	De-selected	4	1.69 (0.08)	4	66.4 (5.6)	4	10.0 (3.4)	4	10.3 (2.5)	4

Loughborough Soccer Passing Test (LSPT

The LSPT, a valid and reliable test of soccer skill performance (Ali et al., 2007), requires participants to complete 16 passes against coloured target areas attached on wooden benches. The players start in the middle of the testing area and have to move into the designated area to pass the ball (Figure 6.1). They have to respond to the examiner's call to perform the passes (towards one of four coloured target areas). The players are instructed to perform the passes as quickly and accurately as possible. The players completed the LSPT twice, with 5 min rest in between the trials. The best trial was taken as the performance score. Before the first trial they were given five opportunities to accustom themselves to the protocol. Two outcome performance measures were calculated: a) execution time, the time taken to complete the 16 passes and b) skill performance time; this consisted of the execution time plus the addition of penalty time and after subtraction of bonus time. Penalty time was awarded for missing the bench (5 s), missing the coloured target area (3 s), handling the ball (3 s), passing the ball from outside the designated area (2 s), ball touching a cone (2 s) or performing the test over 43 seconds (i.e. 1 s awarded for each additional second over this allocated time). Bonus time (1 s deduction) was awarded if the player hit the middle 10-cm strip of the coloured target area.

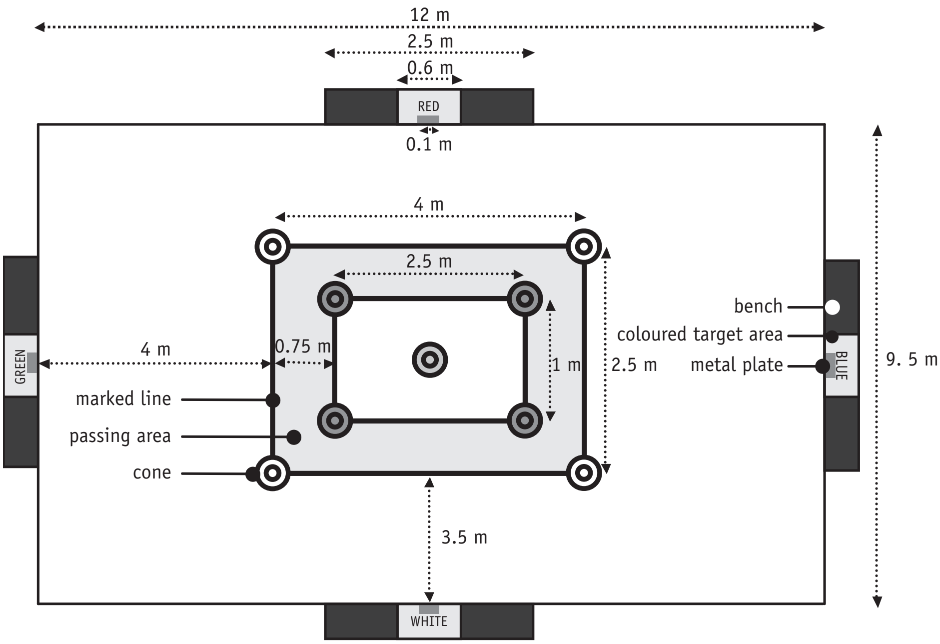

Figure 6.1 Diagrammatic representation of the of the Loughborough Soccer Passing Test (Ali et al., 2007)

Procedures

All players and parents were informed about the procedures of the study before giving their consent to participate. The clubs and the trainers gave permission for this study. The study fits the established ethical standards for sports medicine (Harriss & Atkinson, 2009) and all procedures were in accordance with the ethical standards of the Medical Faculty of the University of Groningen. measurements were taken during the competitive season on an artificial grass soccer field, in dry weather (12-16°C), and with players wearing their standard moulded studs. During testing, the players were unaware of whether the club would retain them within the following year's development program. Similarly, the trainers, coaches and academy staff were not given access to the test results to help make decisions on whether to select or de-select players for the following season. Therefore the study had a double-blind design.

Statistical analysis

Evolutions on LSPT execution time and skill performance time were investigated using the multilevel modelling program MLwiN 2.02 (Rasbash et al., 1999). Multilevel models can handle data which are not independent as is the case in a quasi-longitudinal design, in which measurements are nested within players. The advantage of multilevel models is that the number of measurements and the temporal spacing of measurements may vary between players, assuming that the missing data are at random (Landau & Everitt, 2004; Peugh & Enders, 2005). In other words, it is not necessary to have the same number of measurement occasions per player. Often in longitudinal studies, players leave the study (de-selected from the program) or miss one or more measurement occasions due to injuries, illnesses, or other reasons. Nevertheless, all of the available results can be incorporated within the analysis (Rasbash et al., 1999). The multilevel analysis created models of the LSPT performances (execution time and skill performance time). The multilevel models are created whereby Level 1 scores are the repeated measures within individual players and Level 2 values are the differences between individual players. Possible predictors for the multilevel model are age and age2. Both age and age2 were entered in the model to find the best model fit. The hypothesis was that LSPT performance would increase most rapidly at a younger age; at an older age, the improvement per year was expected to be less. Therefore, age2 was also entered in the model i.e. to indicate if the best model fit was a linear or quadratic curve, or a combination of both. Random intercepts considered thus allowing a unique intercept for each individual player (Peugh & Enders, 2005). In addition random slopes were entered into the model, to properly account for correlations amongst repeated measures within individuals. Hence, we hypothesize a variation in development between players (Plamondon & Alimi, 1997; Reilly & Holmes, 1983). The predicted variables were entered separately into the initial model; during each step goodness of fit was evaluated by comparing the -2*Log Likelihood (IGLS deviance) of the previous model, with the most recent model. Variables that were not statistically significant ($p < 0.05$) were removed from further analysis. Predictions (and 95% CI) were calculated based on the final models.

To analyze the second goal of the study, independent sample t-tests were conducted to examine the scores at the end of the season between selected and de-selected players (SPSS version 16.0). The LSPT execution time and the skill performance time were compared between the two groups for every age group separately. To correct for multiple testing the Bonferroni method was used. An alpha of 0.05 was adopted for all tests of significance. Data are presented as means ± SD or SE (Mlwin data).

Results

The evolutions on the LSPT results are given by the final longitudinal models for the LSPT execution time as well as skill performance time. These multilevel models included age and age2, with both significantly improving the model ($p < 0.05$). The random slopes also improved the model ($p < 0.05$), indicating that the relationship between age and LSPT execution time and skill performance time is not the same for all players but rather distributed randomly. The final estimated models are presented in Table 6.3; the following equations are derived from these models:

LSPT execution time = 86.40 – 5.05 × age + 0.14 × age2
LSPT skill performance time = 175.54 – 14.61× age + 0.42 × age2

Thus, the development of the LSPT execution time and the LSPT skill performance time can be predicted with the multilevel models. For example, it is predicted that a player attending a development program at age 15 scores on the LSPT execution time: 86.40 – 5.05 × 15 + 0.14 × (15)2 ≈ 42.2 s and on the LSPT performance time: 175.54 – 14.61 × 15 + 0.42 × (15)2 ≈ 50.9 s.

The predicted curves for the LSPT execution time and the LSPT skill performance times are plotted in Figure 6.2. The graph shows that both execution time and skill performance time improve by increasing age ($p < 0.001$). In comparison to the execution time, the skill performance time shows greater improvement, especially from age 10 to age 15. The predicted improvement in execution time during this age span is 8 s versus 8 s + 11 s (19 s) in skill performance time. The predicted development on the LSPT execution time and LSPT skill performance time in the players from age 16 to age 18 is limited (both < 1.5 s).

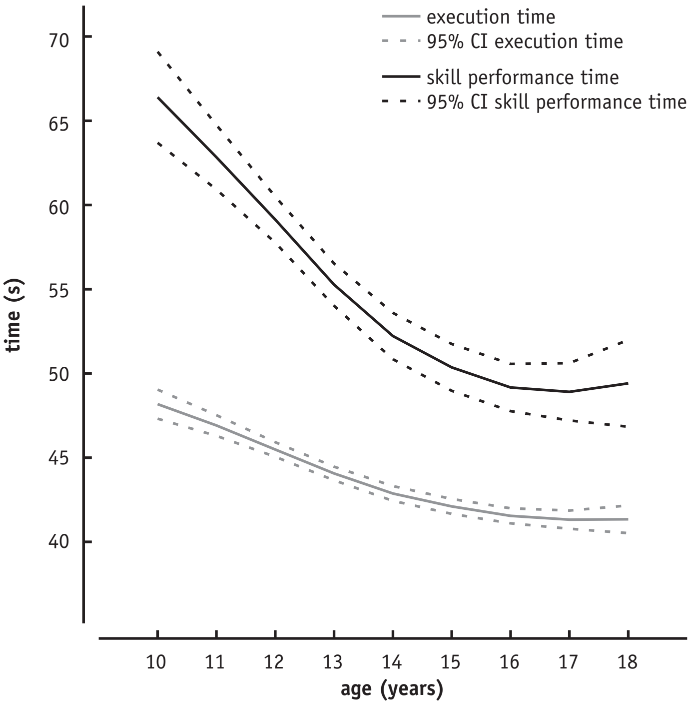

Figure 6.2 Predicted development on the LSPT execution time and skill performance time

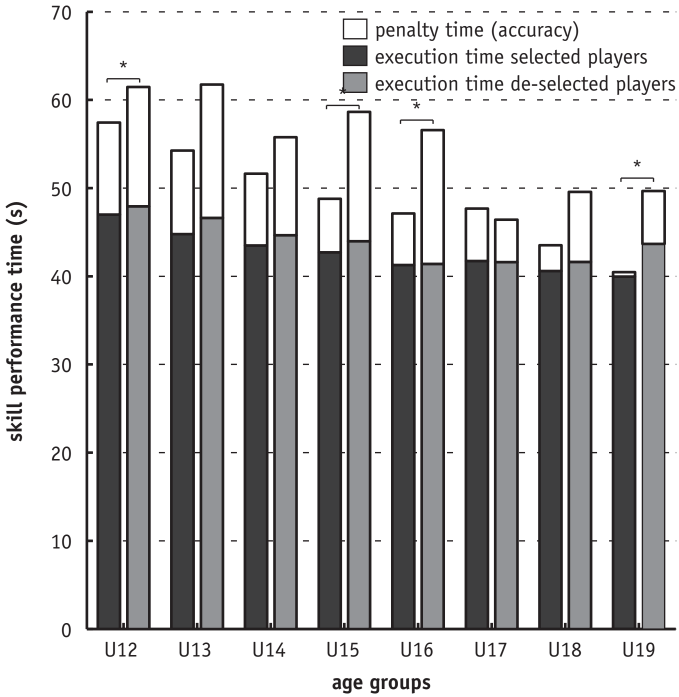

Figure 6.3 LSPT skill performance time (execution time plus penalty time) for all age groups and separately for selected and de-selected players
* $p < 0.05$ in skill performance time between selected and de-selected players

Figure 6.3 shows the LSPT results at the end of the season for every age group separately for the selected and de-selected players. The execution time is either slightly faster in favor of the selected players or, for some age groups, equal to the de-selected players. Analyses did not show significant differences in any age group between the selected and de-selected players on execution time ($p > 0.05$). In contrast, the results indicate that the selected players outperformed the de-selected players in skill performance time for every age group, except for U17. Significant differences in skill performance time between the two groups were found in the age groups U12, U15, U16, and U19 ($p < 0.05$).

Discussion

The purpose of the study was to gain more insight into the development of soccer skills, measured with the LSPT, needed to compete in high performance youth soccer. The quasi-longitudinal study showed improved LSPT results over age in execution time, but more considerable in skill performance time (which also includes accuracy). The test was also able to distinguish between players who were selected versus those individuals who were de-selected for the following season on LSPT skill performance time.

The first part of the study investigated the development of essential soccer skills (including passing, dribbling, control, and decision making regarding the execution of the skills) in youth players of various ages attending a development program of a professional soccer club. The time to complete the LSPT improved over the years (18%, $p < 0.001$), however, the skill performance time improved to an even greater extent (32%, $p < 0.001$). The players selected for the development programs were, at a young age, already able to execute the test at a high speed, however with less accuracy and/or inferior decision-making regarding the execution of the technical skills compared to their performance at an older age. For example, a 12 year old player is predicted to have an execution time of approximately 46 s and at age 17 of approximately 41 s, therefore improving 5 s. However, skill performance time is predicted to improve to an even greater extent with approximately 5 s + 7 s (12 s) from 61 s to 49 s during the same age span. Since the tested players were able to improve their skill performance time, their passing accuracy and control of the ball developed to a greater extent (Ali et al., 2007).

The observed results of the tested players are in line with the performances of earlier research in semi- and ex-professional players in England (age 20 ± 1.5 y). Their LSPT execution time was approximately 40.2 s, and their skill performance time 43.6 s (Ali et al., 2007). The U18 and U19 selected players' average execution times were 39.8 and 39.4 s, respectively, and their skill performance times were 42.7 and 40.5 s, respectively. This suggests that the selected players (especially the U19 group) of the current study performed better (faster skill performance time of 3.1 s) than the semi- and ex-professional players in the Ali et al. (2007) study. Results showed that LSPT execution time did not significantly differ in any of the age groups between selected and de-selected players. However, the selected players outscored the de-selected players on skill performance time in 4 age groups ($p < 0.05$). Although there appeared to be differences between more age groups for selected and de-selected players, not all comparisons were significantly different and were probably the result of the small numbers of de-selected players. The selected players were able to perform the test equally as fast as the de-selected players but were more accurate in their passing and ball control (cf. Fitts & Posner, 1967; Knapp, 1963). Earlier studies have acknowledged that both speed and accuracy are necessary elements for performance in high strategy sports (Andersen & Dorge, 2011; Coelho e Silva et all., 2010; Grehaigne, Godbout, & Bouthier, 2001; Rampinini et al., 2007; Zhongfan, Inomata, & Takeda, 2002). The results of the current study imply that within a group of high performance youth players the distinguishing factor in performance level is related to accuracy rather than the speed of the movement alone.

Selected players were more precise in their passes and ball control, especially whilst under constraints of time. Time-pressure is a key factor wherein players must process visual information quickly and perform motor responses with maximal accuracy (Zhongfan et al., 2002). This phenomenon is explained in motor control studies. The 'speed-accuracy trade-off' hypothesis suggests that to achieve greater accuracy, the execution time increases (Fitts, 1954). Schmidt, Zelaznik, Hawkins, Frank, and Quinn (1979) showed that in single-aiming tasks accuracy is inversely and linearly related to the movement time. Comparable results have also been found in darts players; subjects were less accurate when attempting to throw the dart with maximal force than with normal force (Etnyre, 1998). Andersen and Dorge (2011) also reported that, during soccer, players reduced the maximal speed of the ball by 15% when kicking the ball towards a target as opposed to kicking for distance. It would be interesting to further investigate whether de-selected players are able to execute the LSPT with similar accuracy as selected players when given more time to complete the test (increase of execution time). In addition, insight could be gained if selected players become even faster when their accuracy would be similar to that of de-selected players.

A limitation of the LSPT is that test performance is yet different from the actual game situation. The LSPT measured time constraints, but in games, players also have to deal with other factors such as the pressure of opponents, looking for teammates who are uncovered, and stress (Mcpherson & Kernodle, 2003); players constantly have to deal with a complex and rapidly changing environment (Janelle & Hillman, 2003; Starkes, 1987). By means of the LSPT the combination of many different soccer-specific skills, including decision making regarding the execution of the skills and how to manoeuvre around the grid, are measured. However, the actual decision-making regarding game situations, knowing what to do in a specific situation and actually performing the right action at the right moment is not covered in this specific field test (Elferink-Gemser, Visscher, Lemmink, & Mulder, 2004; Grehaigne & Godbout, 1995; Grehaigne et al., 2001; Kannekens, Elferink-Gemser, Post, & Visscher, 2009; Kannekens, Elferink-Gemser, & Visscher, 2011). Novel measurement devices that can objectively measure the players' 'total' performance during actual competition should be developed to measure the actual game performances (Elferink-Gemser, Kannekens, Lyons, Tromp, & Visscher; Plamondon & Alimi, 1997; Vaeyens et al., 2008). Another shortcoming of the current study was the average low numbers of measurements per player, on average 2.4 measurements per player were taken. The advantage of the multilevel analysis used in the present study is that various measurements are allowed per player. The reasons for the low number of measurements were drop-out (de-selection), injuries and no follow-up (testing stopped). Assuming that the largest part of the missing data is random, we expect the current data to give a good illustration of the evolution of LSPT performance in talented young soccer players. The current study's sample size in the de-selected players is fairly small in comparison to the selected players. For that reason it was impossible to perform a longitudinal analysis comparing the development of selected versus de-selected players and a cross-sectional analysis was performed instead. Future research is recommended to include a larger cohort, which in addition will give possibilities to longitudinally compare the development of selected versus de-selected players on the LSPT and investigate possible performance differences between field positions. Furthermore, to get insight in the performance differences on the LSPT in (talented) players, it might be helpful to compare high, moderate and low level players for their LSPT performance. Another interesting aspect would be the comparison of talented players across countries and continents thus allowing for the examination of possible cultural and performance differences.

The results of the study could be useful in practice; the multilevel models make it possible to compare the development of a highly talented young soccer player with the acquired performance curves. This allows trainers and coaches to assess an individual's performance relative to these curves. Applying the curves, trainers and coaches can determine if player X is performing above or below average for his age. The curves indicate the desired development on the LSPT of talented youth soccer players attending development programs. It should be noted, however, that the sample size in this study is rather small, and it is suggested that future research is conducted with larger groups. Furthermore, soccer skill requirements are changing over the years, therefore the soccer players' performances need to improve constantly (Vaeyens et al., 2006). Hence, although players should improve execution time, more important to belong to the selected players' group seems to be their accuracy. It can be concluded that in top level youth soccer, the combination of speed and accuracy in soccer skills might be more important than speed alone. The models created in this study can be examined in talented players, who are recommended to be tested annually to indicate if having superior accuracy on the LSPT is indeed a good predictor for the selection process and eventually for future performance levels.

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Chapter 7

Discussion

The aim of this thesis was to gain more insight into the talent development and selection process of youth soccer players by examining the development of important technical skills and related factors influencing the soccer performance. To achieve this goal youth soccer players (age 10-21 years) performing at the highest performance level in their age category were included in the current study.

Development of technical skills

Earlier research has stressed the importance of technical skills in soccer, however hardly any information existed about the development of these skills in players of a high performance level. The longitudinal study in chapter 2 showed that dribbling performance improves with age, which is illustrated in Figure 1.1 in the introduction by the arrow. The technical skill dribbling is assessed by means of two field tests, the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test (Lemmink, Elferink-Gemser, & Visscher, 2004). The largest improvements on dribbling occur during the youngest ages in the development program (ages 12 and 13). During these first two years, the improvement in both the dribble tests exceeded 40% of the total improvement in the eight years of the development program. From ages 14 to 16, dribbling hardly improved which might be caused by their peak height velocity, the maximum velocity in growth during adolescence (Beunen et al., 1992; Meylan, Cronin, Oliver, & Hughes, 2010; Philippaerts et al., 2006). The peak height velocity can cause the phenomenon of temporary decline in performance or disruption of motor coordination ("adolescent awkwardness") (Butterfield, Lehnhard, Lee, & Coladarci, 2004). After this period, it was found that from age 16 to 19 dribbling performance improved yet again considerably. This improvement was mainly remarkable in the Slalom Dribble test in which the players showed another improvement of around 1 s, compared to a total 2.5 s improvement from ages 12-19. The larger improvement on dribbling agility compared to dribbling acceleration, might be explained by multi-faceted components influencing agility performance (Sheppard & Young, 2006). One of these components, largely influencing agility is motor coordination. During peak height velocity a temporary decline or stabilization of motor coordination occurs (Butterfield et al., 2004). After this period of growth and change the players show remarkable improvements in their motor coordination, and therefore also on the more coordinative Slalom dribble test. In talent development research it is of the utmost interest if differences exist between initial skill level and the development of skills between players that ultimately reach professional soccer versus amateur soccer. In chapter 4 it is shown that the players who turned professional outscored the players who turned amateur on the technical skill dribbling during adolescence from age 14 to age 18. These results indicate that players who are predicted to become a professional player possess a high level of the technical skill dribbling around the age of 14 and yet develop this skill over time. However, the error bars of the results indicate quite large variation between players. Therefore, by selection players on only the technical skill dribbling on this test, one should keep in mind the individual variation in development and that this is only one performance characteristic. It might therefore be possible that a player is performing below average on the Shuttle Dribble Test, but still has a large chance to become a professional player because of other outstanding performance characteristics.

In chapter 3, sprinting and dribbling performances were tested in national Indonesian youth players before and after a twelve week intensive training period. A low positive relation was found between the peak sprint and dribble performance improvement ($r = 0.26$). Furthermore, it is indicated that the baseline performance level influences the amount of improvement in dribbling, this supports the law of diminishing returns (Farlinger & Fowles, 2008). Players with a higher performance level before the training period did not improve as much as the players with a lower performance level.

In soccer, the players often execute a combination of technical skills during a game, such as a sequence of ball control, dribbling and passing. In chapter 6 the development of these skills are measured using the Loughborough Soccer Passing Test (LSPT) (Ali et al., 2007) in a longitudinal design. The largest improvements occurred during younger ages (ages 10 to 15). Speed as well as accuracy improve largely during this age span. Comparing the particular development of speed on the LSPT to the dribbling speed development, it is remarkable, that the speed in the LSPT (operation speed) does improve during peak height velocity, while a lack of progress in dribbling speed development was found. This finding does indicate that adolescence awkwardness is more visible in dribbling speed. Dribbling speed involves fundamentally gross motor coordination compared to operation speed, which includes mostly the fine motor control.

From age 10 until age 18, the time to complete the LSPT (speed) improved over the years (18%) however, the skill performance time (speed + accuracy) improved to an even greater extent (32%). The players selected for the development programs were, at a young age, already able to execute the test at a high speed, however with less accuracy.

Relation between technical skills and other performance characteristics

The technical skill dribbling is assessed by means of two field tests, the Shuttle Sprint and Dribble Test (ShuttleSDT) and the Slalom Sprint and Dribble Test (SlalomSDT). In chapter 2 these two tests are compared. Low correlations were observed between dribbling ($r = 0.22$), indicating that each test measures distinct qualities. The ShuttleSDT measures straight line sprinting and dribbling, in combination with 180 degree rotations, assessing acceleration of the players. The SlalomSDT measures the agility of the players important in game situations to deceive opponents. Both tests measure the performance of dribbling by means of speed. Players need to perform the test at a high speed, with the least possible errors. Errors increase their execution time, and result in a slower performance. In Chapter 6, the outcome of time and accuracy are tested separately with the Loughborough Soccer Passing Test. The results showed that differences in performance, within a group of all talented players, are mainly indicated by the accuracy component of the technical skill. Both selected and de-selected players executed the test with the same speed, however the selected players performed the test more accurate than the de-selected players.

Correlations between sprinting and dribbling within both the ShuttleSDT and SlalomSDT are performed to indicate to what extent sprinting and dribbling performance represent similarities. Low-to-moderate correlations were found between dribbling and sprinting (ShuttleSDT: $r = 0.54$; SlalomSDT: $r = 0.38$). This indicates that sprinting explains partly the dribble performance and that not only sprinting is the fundamental skill which relates to increased dribbling performance. Moreover, increased age, more lean body mass, and additional hours of training contribute positively to dribbling performance (chapter 2). Furthermore, dribbling performance on the SlalomSDT showed to be different for playing positions, whereby midfielders performed the best, followed by attackers and defenders. However, the measured variables do partly explain the dribble performance, many more factors or abilities which are not measured during testing are involved in technical dribbling performance. Dribbling is for instance also largely affected by coordination (gross body and foot-eye), motor control, reaction time, and strength (McMorris, 2004; Davids, Lees, & Burwitz, 2000). These actors also show a development during youth and adolescence influencing the outcome of skill performance.

In soccer it is obvious that on-the-ball-performance (technical skills) are a requirement for performance. However, other multidimensional characteristics also play a prominent role, especially when performing at the highest performance level. In chapter 5 it is shown that clubs select or de-select players (aged 16 to 19) in their talent development program mainly by the players' technical and tactical skill performances. Therefore the ability to execute the technical skill is not enough to perform at a high level, choosing the right technical skill at the right moment is of great importance as well (Baker, Cote, & Abernethy, 2003; Grehaigne, Godbout, & Bouthier, 2001). The finding of the current study corroborates research within the same Dutch development programs, which has acknowledged the positive relation between the level of tactical skills and the (ultimate) level of soccer performance (Kannekens, Elferink-Gemser, Post, &Visscher, 2009a; Kannekens, Elferink-Gemser, & Visscher, et al., 2009b).

Recommendations for future research

The current thesis research objectively illustrated the development of technical skills in youth players of a high performance level. The majority of the studies investigated the technical skill dribbling, since dribbling is found to be important during the crucial moments of the game and in addition, dribbling is a skill that discriminates between performance levels (Malina et al., 2005; Rampinini et al., 2007; Reilly, Williams, Nevill, & Franks, 2000; Vaeyens et al., 2006). The technical skills ball control and passing are also addressed in the current thesis. However, more technical skills exist which are decisive for success. Future research should therefore in addition investigate the development of for example shooting, long passing and crossing (Rampinini et al., 2007; Taylor, Mellalieu, James, & Shearer, 2008). Technical skill development is thoroughly investigated in the current thesis while the players were part of a development program. However, it is also of great interest to investigate possible skill differences in even younger players, which can serve as a handle in the talent identification process.

The skill performance data which were collected by means of the field tests showed the initial levels and the development of the players. The reason to choose these tests was because they represent the important technical skills performed in a game, including the components speed and accuracy. However, the test performances are yet different from the actual game situation. Important technical skills and its related factors are tested in a closed environment. Chapter 2 to 4 described the level and development of skill performance on a prescribed track (for example slalom dribble track). In chapter 6, players constantly had to react rapidly and accurately to the task, which involved passing in one of the four directions. However, the actual game is played with a team of eleven players. The players compete at the same field of action as their opponents. Therefore the players constantly have to adapt to opposition by punctual adaptation to new play configurations and to the circulation of the ball. They have to deal with a complex and rapidly changing environment (Hughes & Bartlett, 2002; Williams, 2000). Playing at a high level of performance in soccer means choosing the right skill at the right moment (Baker et al., 2003; Grehaigne et al., 2001). Excellent technical skills and related factors such as sprinting, refer to more selection possibilities available for the players and at the same time being able to execute the actions more quickly and accurately (Visscher, Elferink-Gemser, Richart, & Lemmink, 2005). As a result, to be an outstanding player, the correct (technical) skill needs to be selected and performed as determined by the demands of the situation (Ali et al., 2007). The actual decision-making regarding game situations, knowing what to do in a specific situation and actually performing the right action at the right moment is not covered in the executed field tests (Elferink-Gemser, Visscher, Lemmink, & Mulder, 2004; Grehaigne & Godbout, 1995; Grehaigne et al., 2001; Kannekens et al., 2009a; Kannekens, Elferink-Gemser, & Visscher, 2010). Novel measurement devices that can objectively measure the players' 'total' performance should be developed to measure the actual game performances (Elferink-Gemser, Kannekens, Lyons, Tromp, & Visscher, 2010; Vaeyens, Coelho e Silva, Visscher, Philippaerts, & Williams, 2013; Vaeyens, Lenoir, Williams, & Philippaerts, 2008).

The current thesis research has shown that dribbling performance develops over time. Several studies have reported that time spent in practice is a strong discriminator across levels of skill, with elite youth players spending much more time practicing than sub-elite players (Helsen, Starkes, & Hodges, 1998; Ward, Hodges, Starkes, & Williams, 2007). Expert performance is determined by the amount of time and more importantly the quality of practice activities with the primary goal of improving some aspect of performance, i.e., deliberate practice (Ericsson, Krampe, & Teschromer, 1993; Jones, Hitchen, & Stratton, 2000). Results of chapter 2 and 4 underline the importance of (soccer) training in relation to (skill) performance. Intervention studies could more clearly define the effect of different types of training on technical skill performance development. With regards to the results in chapter 4, a recommendation for an intervention study is to individualize the training programs. The individualized training programs might include individual exercise prescriptions related to for example the baseline performance level or position (chapter 3) of the players.

In the introduction it is referenced that the theoretical framework to guide talent development programs should take into account both the dynamic and multidimensional nature of talent (Phillips, Davids, Renshaw, & Portus, 2010; Vaeyens et al., 2008). The studies in the current thesis investigated group means, however individualized pathways to expert performance are expected because of the uniqueness of the dynamics constraints (Phillips et al., 2010). The excellence in a sport can be achieved in unique ways through different combinations of abilities. This effect has been termed the "compensation phenomenon" and suggests that deficiencies in one area of performance may be compensated for by strength in others (Meylan et al., 2010; Bartmus, Neumann, & de Maree, 1987). Therefore, future talent development models should take into account the different rates of learning, and growth and maturation processes experienced by players on their road to professional soccer.

The multidimensional nature in soccer is acquired by physiological, technical tactical, and psychological characteristics (Burgess & Naughton, 2010; Figueiredo, Goncalves, Coelho E Silva, & Malina, 2009; Helsen & Starkes, 1999; Reilly et al., 2000; Vaeyens et al., 2006; Ward & Williams, 2003). During youth and adolescence players develop themselves virtually in every aspect of these multidimensional performance domain, therefore technical skill development should be investigated in relation to the development of the other multidimensional performance characteristics. For instance, information about the psychological characteristics of talented soccer players is scarce. However, many required skills in soccer may be translated to general cognitive domains, a player must be able to quickly adapt, change strategy and inhibit responses, referred to as "game intelligence" in sports (Stratton, Reilly, Richardson, & Williams, 2004), or more generally as executive functions (Strauss, Shermanm, & Spreen, 2006). Recently executive functions predicted future success measured in goals and assists, suggesting a causal role for executive functions for sport success in soccer (Vestberg, Gustafson, Maurex, Ingvar, & Petrovic, 2012). The executive functions are considered to develop progressively throughout childhood and adolescence from birth to 19 years of age (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001). The relation between the development of these executive functions and technical skill and soccer success is however unknown. Future research should focus on this, because it might predict the potential of players and therefore be very interesting for talent selection and development.

Implications and conclusions

The current thesis research has gained greater insight into the talent development and selection process by examining the development of important technical skills and its related factors influencing the soccer performance. Youth soccer players (age 10-21 years) performing at the highest performance level in their age category were included in the current studies. The longitudinal study in chapter 4 showed that talented youth soccer players who ultimately make it to the top performed better on the technical skill dribbling during adolescence than their less successful counterparts. Successful players seem to have acquired better dribbling skills already by the age of fourteen. Furthermore it is observed that dribbling continues to improve after peak height velocity. In Chapter 6 it is indicated that the differences in execution technical skills are primarily found on the accuracy part. Both selected and de-selected players executed the skills with the same speed, however the selected players outscored the de-selected players on accuracy.

From the studies in the current thesis practical implications for trainers, coaches, scouts, parents and players can be derived. It should be acknowledged that the development of a youth soccer player towards a professional career is a long process in which many years of dedicated training have to be invested. The players ultimately reaching professional status acquired on average better dribbling skills by the age of fourteen. The derived curves of the ultimate professional players make it possible to compare the development of a youth soccer player with these performance curves. This allows trainers and coaches to assess an individual's performance relative to these curves. Applying the curves, trainers and coaches can determine if player X is performing above or below average for his age. Since the studies also presented possible underlying mechanisms of technical skill performance, it can also be indicated which factors may be responsible for eventual poorer performance.

It should be acknowledged that soccer skill requirements are changing over the years, therefore the soccer players' performances need to improve constantly (Nevill, Holder, & Watts, 2009). Professional soccer is played at a higher 'tempo' than 10 years ago (Vaeyens et al., 2008). Recently it is shown that intermittent endurance capacity and shuttle dribble performance in young talented players has improved over the last ten years (Elferink-Gemser et al., 2012; Huijgen, Elferink-Gemser, & Visscher, 2012). Consequently, the created curves should be adjusted when soccer is played at a 'higher' tempo.

The results of the current thesis research have provided objective data about technical skill performance in high performance youth soccer players. The information on the technical skill development, and factors related to soccer performance are useful key elements in the talent development and selection process. Objective technical skill performance scores of players can be compared to the desired curves, which provides valuable practical information concerning the road to success of talented players.

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Summary

The current thesis research has resulted in increased insight into the process of talent development in talented youth soccer players. The main question addressed was: what are the differences between talented players ultimately reaching professional soccer versus players reaching amateur soccer? The theoretical framework used to investigate the development of the talented players took into account both the dynamic and multidimensional nature of talent. The dynamics of the players are developed by constraints including maturation, training, learning, and environment, which all interact to shape their performance. The multidimensional nature in soccer consists of the following performance characteristics: anthropometric, physiological, technical, tactical and psychological characteristics. Since technical skills are crucial in soccer performance the focus in the current thesis research was on the development of these essential soccer skills, such as dribbling and passing. Technical skills are effective if executed under high-velocity (speed) and accurately. The current thesis gained insight into the talent development and selection process of youth soccer players by examining the development of technical skills in relation to soccer performance. The development of the talented players were mainly investigated using a longitudinal design. The talented soccer players (aged 10-21 years) were monitored during adolescence while playing at the highest level in their age category.

The technical skill dribbling is measured by means of two field tests, that is the Shuttle Sprint and Dribble Test (ShuttleSDT) and the Slalom Sprint and Dribble Test (SlalomSDT). Both tests investigate the sprint and dribble performance over 30 m. The ShuttleSDT measures the sprint and dribble performances over short distances in a straight line. During the performance of these sprints and dribbles the acceleration of soccer players is also measured, because the players sprint/dribble over short distances (5-10 m) and have to turn three times 180°. The test is executed repeatedly to examine the sprint and dribble performance under fatigue. The SlalomSDT measures the more soccer-specific action of deceiving an opponent by slalom sprinting or slalom dribbling with quick changes of direction. The development of sprinting and dribbling on both tests were investigated using a longitudinal design. Chapter 2 illustrated the results on these tests in talented players aged 12 -19. The players showed improved development of sprinting and dribbling over the years in both the ShuttleSDT and the SlalomSDT. At age 12, the players performance on the sprint was on average 8.7 s, on the dribble 10.4 s, on the slalom sprint 15.2 s and on the slalom dribble 23.0 s. From age 12-19, sprinting improved on average around 0.7 s, shuttle dribble 0.9 s, slalom sprint 1.6 s and slalom dribble 2.5 s. The largest improvements on both dribbling and sprinting occur during the youngest ages (ages 12 and 13). During these first two years, the improvement exceeded 40% of the total improvement in the eight years. From ages 14 to 16 sprinting still improved rapidly in contrast to dribbling which hardly improved. In contrast, after age 16 dribbling improved considerably, for example around 1 s improvement in the slalom dribble, but slalom sprinting hardly improved.

The sprinting and dribbling development in National youth players (average age of 20 years) in a twelve week training period is illustrated in chapter 3. The players significantly improved on both their peak and repeated sprinting from on average 8.2 s to 7.9 s, respectively 59.7 s to 51.4 s. No significant improvement was found on dribbling, but a significant improvement on repeated dribbling was present from on average 63.3 s to 60.8 s. As expected it was found that the baseline performance level influences the amount of improvement in both sprinting and dribbling, the players with a higher performance level before the training period did not improve as much as the players with a lower performance level.

The difference between developmental patterns on dribbling between talented players ultimately reaching professional soccer and players reaching amateur soccer were analysed in chapter 4. The relationship between the development of dribbling during ages 14 to 18 and adulthood playing level (professional versus amateur) were studied. The longitudinal results showed that during adolescence the talented players who ultimately became professionals were on average 0.3 s faster on dribbling. In addition the future professional players were from age 14-18 on average 1 s faster on repeated dribbling performance than the future amateurs.

As the youth players progress through the developmental program, some players are allowed to continue training (selected) while others are forced to leave (de-selected), at the end of each season the developmental program decide upon this. Given that technical skills are only one of the multidimensional performance characteristics in soccer, in chapter 5 it is investigated whether the technical, physiological, tactical and/or psychological performance characteristics can discriminate between selected and de-selected players in talent development programs, aged 16-18. The four domains of multidimensional performance characteristics were assessed by using a test battery consisting of soccer-specific field tests and questionnaires. Differences between selected and de-selected players were found on the ShuttleSDT ; the physiological characteristics sprinting and repeated sprinting, and the technical characteristics dribbling and repeated dribbling, and on the tactical characteristic of 'Positioning and deciding'. Selected players outscored de-selected players on all three performance characteristics.

The success of technical skills is dependent on the interaction between speed and accuracy of execution these skills. Therefore, chapter 6 showed information that included these components of speed and accuracy with separate outcome measures. Talented young soccer players were tested by means of the Loughborough Soccer Passing Test (LSPT). The players showed improved LSPT results on speed alone from age 10-18, but more considerable on the combination of speed and accuracy during this age span. The test was also able to distinguish between selected and de-selected players on the combination of speed and accuracy on the LSPT. It can be concluded that in top level youth soccer, the combination of speed and accuracy in soccer skills might be more important than speed alone.

The theoretical framework of talent development which is illustrated in the Introduction states that the dynamic and multidimensional nature of talent should be taken into account. In the studies in the current thesis group means are investigated, however individualized pathways to expert performance are observed. Reaching the top in soccer can be achieved in unique ways through different combinations of abilities and dissimilar pathways of development. Therefore, future talent development models should take into account the different rates of learning, and growth and maturation processes experienced by players on their road to professional soccer.

It can be concluded that players ultimately reaching professional status acquired on average better dribbling skills by the age of fourteen. Players improved their technical skill even after their growth spurt, this in contradiction to sprinting which reaches a plateau after their growth spurt. Differences between players were primarily found on the combination of speed and accuracy part of the technical skills, this seems more important than speed alone.

Developmental programs can benefit from the results in the current thesis. Developmental programs are recommended to test the players periodically. The performances and the development of a player can be compared to the desired curves. It should be kept in mind that soccer is evolving over time and therefore the performance curves should also be adjusted. The objective information can give insight for both the developmental program and the player itself if a player is performing below average and needs specific training to improve certain aspects. The test results can also support in the selection process of the developmental programs. The players who are on the right line on their way to the top, should stay within the developmental program, because they have the biggest chance to ultimately become a professional player.

Samenvatting

Voetbal is wereldwijd de meest populaire sport, ook in Nederland is dit het geval. Er zijn meer dan 1,2 miljoen spelers lid van een voetbalclub in Nederland. Bijna elke jeugdspeler droomt er van om profvoetballer te worden, maar slechts een heel erg klein percentage (± 0,1%) slaagt er uiteindelijk in om de top te halen. Voor spelers is het van belang dat ze inzicht krijgen in de eisen die gesteld worden om de weg naar de top te halen. Zo zal het van grote meerwaarde zijn voor getalenteerde spelers als ze weten hoe ze zich moeten ontwikkelen op verschillende aspecten. Bij inzicht in deze gegevens kunnen ze ook beter begeleid worden in hun ontwikkeling en dan hebben ze de grootste kans om hun potentie waar te maken. Voor voetbalclubs is het ook van groot belang om spelers uit de eigen jeugdopleiding door te laten stromen naar het eerste team. Als er spelers uit de eigen opleiding kunnen doorstromen, is een investering voor het aantrekken van spelers van buitenaf niet nodig. De talentontwikkeling is dus erg belangrijk, maar tot op heden zijn er weinig objectieve gegevens bekend over de weg van getalenteerde spelers naar de uiteindelijke top.

Dit proefschrift geeft inzicht in de ontwikkeling van getalenteerde jeugdvoetballers. De hoofdvraag die gesteld is, luidt: wat zijn de verschillen tussen getalenteerde spelers die uiteindelijk in het profvoetbal terecht komen en spelers die in het amateurvoetbal gaan spelen? Het theoretische kader dat geschetst is om de ontwikkeling van getalenteerde spelers te onderzoeken, houdt rekening met zowel de dynamische als het multidimensionele karakter van talent. Het dynamische karakter van talent wordt bepaald door de groei en rijping, training, de manier en snelheid van leren en de omgeving, dit draagt samen allemaal bij aan de uiteindelijk prestaties. Het multidimensionele karakter van voetbal bestaat uit een combinatie van prestatiebepalende kwaliteiten: antropometrie (lichaamsbouw), fysieke, technische, tactische en mentale eigenschappen. Aangezien technische vaardigheden van wezenlijk belang zijn in het voetbal, ligt de nadruk in de studies op de ontwikkeling van onder meer dribbelen en passen. Het resultaat van de uitvoering van technische vaardigheden is succesvol als ze snel en nauwkeurig worden uitgevoerd.

Dit proefschrift geeft inzicht in het proces van talentontwikkeling en talentselectie van jonge getalenteerde voetballers door de ontwikkeling van technische vaardigheden in relatie met voetbalprestaties in kaart te brengen. De ontwikkeling van de getalenteerde spelers is voornamelijk onderzocht door het gebruik van longitudinaal onderzoek. De voetballers (10-21 jaar) zijn gemonitord terwijl ze op het hoogste niveau binnen hun leeftijdscategorie speelden.

De technische vaardigheid dribbelen is gemeten met twee veldtesten, namelijk de Shuttle Sprint en Dribbel Test (ShuttleSDT) en Slalom Sprint en Dribbel Test (SlalomSDT). Beide testen meten de sprint en dribbel prestaties over een afstand van 30 m. De ShuttleSDT meet de sprint en dribbel prestaties over korte afstanden in een rechte lijn, voetbalkenners kunnen bij deze vorm van dribbelen ook aan drijven denken. Tijdens het afleggen van deze sprints en dribbels wordt ook de versnelling van de voetballers gemeten, omdat de spelers korte sprints/dribbels afleggen (5-10 m) en drie keer 180° moeten draaien. Deze

test wordt herhaaldelijk uitgevoerd om ook het sprinten en dribbelen onder vermoeidheid in kaart te brengen. De SlalomSDT meet het slalomsprinten en slalomdribbelen met snelle richtingsveranderingen, wat iets voetbal specifieker is bij het passeren van een tegenstander. De ontwikkeling op beide testen is onderzocht met behulp van een longitudinaal design. Hoofdstuk 2 heeft de resultaten op deze testen laten zien bij getalenteerde voetballers van 12-19 jaar. De spelers ontwikkelden zich op zowel sprinten en dribbelen op zowel de ShuttleSDT als SlalomSDT. Op een leeftijd van 12 jaar, deden de spelers gemiddeld 8,7 s over de sprint, 10,4 s over de dribbel, 15,2 s over de slalomsprint en 23,0 s over de slalomdribbel. Van hun 12de tot 19de verbeterden de spelers zich gemiddeld 0,7 s op de sprint, 0,9 s op de dribbel, 1,6 s op de slalomsprint en 2,5 s op de slalomdribbel. De grootste vooruitgang op zowel het sprinten als dribbelen vond plaats in de eerste twee jaar (van 12 naar 13 jaar). Tijdens de eerste twee jaar, was de vooruitgang 40% van de totale verbetering over de acht jaar. Van 14 tot 16 jaar ging het sprinten nog steeds snel vooruit, dit in tegenstelling tot het dribbelen dat rond deze leeftijd nauwelijks vooruitging. Hier tegen over staat dat het dribbelen na het 16de jaar nog fors vooruitging, de slalomdribbel ging gemiddeld nog met één seconde vooruit, terwijl het slalomsprinten nauwelijks nog verandering liet zien.

De ontwikkeling van het sprinten en dribbelen bij nationale jeugdspelers (gemiddelde leeftijd 20 jaar) tijdens een trainingsperiode van 12 weken is weer gegeven in hoofdstuk 3. De spelers lieten een significante vooruitgang zien op zowel de sprint als het herhaalde sprinten, van gemiddeld 8,2 s naar 7,9 s, respectievelijk 59,7 s naar 51,4 s. Er was geen significante vooruitgang gevonden op de dribbel, echter wel een significante verbetering op het herhaald dribbelen van gemiddeld 63,3 s tot 60,8 s. Zoals verwacht beïnvloedt het beginniveau van de spelers de mate van vooruitgang in zowel het sprinten als het dribbelen, de spelers die beter presteerden voor de trainingsperiode lieten minder verbetering zien dan de spelers die minder presteerden aan de start.

Het verschil in de ontwikkeling op het dribbelen tussen getalenteerde spelers die uiteindelijk profvoetballer worden en getalenteerde spelers die in het amateur voetbal terecht komen is geanalyseerd in hoofdstuk 4. De relatie tussen de ontwikkeling van het dribbelen van 14 tot 18 jaar en het niveau (prof versus amateur voetbal) waar de spelers als ze volwassen zijn op uitkomen, is bestudeerd. De longitudinale resultaten lieten zien dat de spelers die uiteindelijk profvoetballer zijn geworden, tijdens de jeugd gemiddeld 0.3 s sneller waren op de dribbel. Tevens waren de toekomstige profs van 14 tot 18 jaar gemiddeld 1 s sneller op de herhaalde dribbel dan de toekomstige amateurs.

Tijdens de jeugdopleiding wordt er aan het einde van elk seizoen door de opleiding besloten of de spelers mogen blijven, omdat ze goed genoeg presteren en de potentie hebben om de top te halen, of dat ze niet goed genoeg bevonden worden en de jeugdopleiding moeten verlaten. Technische vaardigheden behoren slechts tot één domein van de multidimensionele prestatie bepalende kwaliteiten in het voetbal. In hoofdstuk 5 is onderzocht of technische, fysiologische, tactische en/of mentale prestatie bepalende kwaliteiten kunnen discrimineren tussen de spelers die mogen blijven in de jeugdopleiding en de spelers die afvallen, in de leeftijd van 16-18 jaar. De vier domeinen van de multidimensionele prestatie bepalende kwaliteiten zijn bestudeerd met behulp van voetbal specifieke veldtesten en vragenlijsten. Verschillen tussen de geselecteerde spelers en de afvallers zijn gevonden op de ShuttleSDT; de fysiologische kwaliteiten sprint en herhaald sprinten en de technische kwaliteiten dribbelen en herhaalde dribbel en op de tactische kwaliteit "Positie kiezen en besluitvorming". Geselecteerde spelers scoorden op alle drie de prestatie bepalende kwaliteiten beter dan de afvallers uit de jeugdopleiding.

Om de technische vaardigheden succesvol uit te kunnen voeren, is zowel snelheid als nauwkeurigheid in het uitvoeren van deze vaardigheden van belang. Daarom is in hoofdstuk 6 een studie uitgevoerd waarin deze componenten snelheid en nauwkeurigheid afzonderlijk gemeten worden. Getalenteerde voetballers zijn gemeten met de Loughborough Soccer Passing Test (LSPT). De spelers lieten vooruitgang zien op de component snelheid van 10-18 jaar, opvallender was de grotere vooruitgang op de combinatie van snelheid en nauwkeurigheid tijdens deze leeftijd. De test was ook in staat om onderscheid te maken tussen de spelers die in de selectie van de jeugdopleiding mochten blijven versus de afvallers op de combinatie van snelheid en nauwkeurigheid op de LSPT. De spelers die in de opleiding mochten blijven en daardoor meer kans maken om profvoetballer te worden, maken op hoge snelheid minder fouten dan de 'afvallers'.

Het theoretische kader van talentontwikkeling dat geïllustreerd is in de introductie, geeft aan dat er rekening gehouden moet worden met het dynamische en multidimensionale karakter van getalenteerde spelers. In de onderzoeken in dit proefschrift zijn groepsgemiddelden geanalyseerd, terwijl er individuele routes op weg naar de top worden gezien. De top halen in het voetbal kan op verschillende unieke manieren door allerlei combinaties van kwaliteiten en uiteenlopende ontwikkelingstrajecten. Het is daarom van groot belang dat toekomstige ontwikkelingsmodellen rekening houden met het verschil in tempo van leren, groei- en rijpingsprocessen die spelers ervaren op hun weg naar het profvoetbal.

De conclusie die we kunnen trekken is dat spelers die uiteindelijk het profvoetbal halen, gemiddeld op hun 14de al over betere dribbelvaardigheden beschikten. Alle talentvolle spelers lieten na hun groeispurt nog een verbetering op het dribbelen zien, dit in tegenstelling tot het sprinten wat na de groeispurt een plateau bereikt had. Verschillen tussen de spelers waren hoofzakelijk gevonden op de combinatie van snelheid en nauwkeurigheid van de technische vaardigheden, dit lijkt belangrijker te zijn dan alleen snelheid.

Jeugdopleidingen kunnen baat hebben bij de resultaten van dit proefschrift. Aan jeugdopleidingen wordt aanbevolen om de jeugdspelers periodiek te testen. De prestaties en de ontwikkeling van een jeugdspeler kunnen vervolgens vergeleken worden met de gewenste ontwikkelingsprofielen. Er moet wel rekening gehouden worden dat het algehele voetbalniveau over de tijd verbetert en de ontwikkelingsprofielen dus ook bijgesteld moeten worden. Met de objectieve informatie kunnen zowel de jeugdopleidingen als de spelers zelf inzicht verkrijgen of een speler achterblijft in prestaties en daarvoor specifieke training nodig heeft om de bepaalde aspecten te verbeteren. De uitkomsten van de testen kunnen ook ondersteunen bij het selectieproces. Zo zouden de spelers die op de goede lijn zitten op weg naar de top, behouden moeten blijven binnen de opleiding omdat zij de meeste kans maken om uiteindelijk profvoetballer te worden.

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Curriculum Vitae

Barbara Huijgen werd geboren op 13 februari 1980 te Goor. Na het behalen van haar VWO diploma aan de Bataafse Kamp in Hengelo in 1998, is zij voor 2 jaar naar de Verenigde Staten gegaan. Barbara heeft aan de University of Texas in Arlington, Exercise Science gestudeerd en 'college tennis' gespeeld. In 2000 is zij gestart met de opleiding Bewegingswetenschappen aan de Rijksuniversiteit Groningen. Haar afstudeeronderzoek heeft zij uitgevoerd aan Boston University, College of Health & Rehabilitation Sciences. Zij heeft het effect van lopen met een rugzak onderzocht. In 2004 heeft zij haar opleiding afgerond met het doctoraalexamen in de richting 'Revalidatie' en 'Sport'.

In 2004 heeft zij een half jaar gewerkt als onderzoeksmedewerker bij een landelijk project in de kinderrevalidatie. In september 2004 startte Barbara met werken bij het Roessingh Research and Development, zij heeft als onderzoeker gewerkt aan verschillende projecten. Deze projecten waren onder andere 'Revalidatie en Sport', het effect van sporten en actief bewegen in het revalidatieproces, myofeedback bij RSI patiënten en een Europese studie over tele-revalidatie (trainen in de thuissituatie).

In juni 2007 keerde Barbara terug naar Groningen en startte zij als promovendus bij het Interfacultair Centrum voor Bewegingswetenschappen. Het doel van het onderzoek was inzicht verkrijgen in het proces van talentontwikkeling bij getalenteerde jeugdvoetballers, met name gericht op de technische kwaliteiten van de voetballers. Vanaf februari 2011 heeft zij haar werkzaamheden voorgezet binnen de opleiding Bewegingswetenschappen als docent. In de komende jaren zal zij het onderzoek binnen de talentherkenning en talentontwikkeling in de sport en met name bij de getalenteerde voetballers voortzetten.

List of Publications

International publications talent development in soccer (peer-reviewed)

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